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PROGRAMING A TEACHING MACHINE COURSE IN THINKING AND PROBLEM SOLVING.

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SKINNER'S VIEWS ON THE NATURE OF THINKING WERE DESCRIBED IN NONTECHNICAL LANGUAGE. THIS LAYMAN'S INTRODUCTION TO SKINNER'S POSITION ON THE NATURE OF THINKING WAS INTENDED FOR USE BY PSYCHOLOGY STUDENTS AND PRACTICING SCHOOL TEACHERS IN THE DEVELOPMENT OF A MACHINE PROGRAM TO TEACH COLLEGE STUDENTS THE BEHAVIORS INVOLVED IN THINKING AND PROBLEM-SOLVING. A TEACHING MACHINE COURSE WAS NOT DEVELOPED. TECHNICAL NOTES WERE PROVIDED WHICH PRESENTED--(1) RATIONALE BEHIND THE WORKING DEFINITION OF THINKING, (2) SPECIFICATION OF BEHAVIORS TO BE PROGRAMED, AND (3) GUIDELINES FOR CONSTRUCTION OF THE TEACHING PROGRAM. REPRESENTATIVE FRAMES WERE ALSO PROVIDED FOR A PORTION OF THE TEACHING PROGRAM WHICH WAS PREPARED BY AN EXPERIMENTAL CLASS. (JM)

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FINAL REPORT TO THE U.S. OFFICE OF EDUCATION, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Project Title: "Programming a Teaching Machine Course in Thinking and Problem Solving"

Project Director: Dr. Willard F. Day, Assoc. Prof. of Psychology

Name of Institution: University of Nevada

Date of Report: January 23, 1964

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The research activities described below have been supported in part by a $2156 "Small Grant" awarded November 28, 1960 by the U.S. Office of Education under the provisions of Title VII of the National Defense Education Act of 1958.

1. Purpose and objectives of the research.

The general problem to which this research is related has been described in the grant application as follows:

> "...The problem seems to be that most psychologists and professional educators do not have the necessary opportunity, or perhaps for that matter the necessary intellectual orientation, to enable them really to understand the Skinnerian's approach to the problems of programming; nor, on the other hand, do the Skinnerians seem to be particularly effective in making their ideas accessible or acceptable to social scientists who are able to spend no more than a fairly limited amount of time in the consideration of what it is that Skinnerians have to say.
>
> "It is the position of this writer that regardless of the ultimate disposition to be made by psychology of Professor Skinner's analysis of behavior, at the present time the originality of his perspective offers one of the most challenging, if not indeed the most promising, avenues of investigation in the field of educational research. Moreover, contrary to the point of view frequently expressed by practicing teachers and certain educational psychologists, it is the opinion of the writer that human thinking and problem-solving, as examples of 'higher' human mental functions, involve for the most part specific behaviors, discriminative and operant in nature, which are essentially similar to the kinds of behaviors generally established today by teaching-machine programs. Therefore, in view of the widespread difficulty with which the uninitiated approach the interpretation of Skinnerian theory and research results, the need arises for relatively clear-cut empirical studies in which Skinnerian theory is reduced to practical application in fairly straightforward educational situations, and in which the functional utility of Skinner's method is simply demonstrated. This proposal stems from a desire on the part of the writer to demonstrate that it is not necessarily a difficult task to inform the typical psychologist and professional educator of the basic characteristics of an essentially Skinnerian approach to teaching-machine programming; to demonstrate, in fact, that it is not particularly difficult to teach the technique of Skinnerian programming to practicing educators who hold full-time jobs teaching in primary and secondary schools; and to demonstrate that even such broad educational achievements as critical and creative thinking lend themselves much as other types of subject matter to successful instruction by teaching machines. The presumption is not made in the preliminary research proposal outlined here that these objectives are easily and quickly to be attained. However a method is suggested by which a first step in such a direction might be taken."

In short, the central aim of this research has been to clarify the technical issues involved in Skinnerian-type programming of higher mental processes, by both constructing a representative program and presenting in association with the program a detailed record of the way in which theoretical issues influenced the structure of the program.

The preliminary nature of the intended research was acknowledged in the grant-application, which identified as follows four specific objectives of the activities to be carried out under terms of the grant:

"Specifically, the objectives of this preliminary research are as follows:

(1) Those aspects of Skinner's theory which pertain directly to human thinking and problem-solving will be critically reviewed and set forth as an integrated unit in a paper designed to be fairly easily understandable to a typical serious-minded elementary or high-school teacher.

(2) Human thinking and problem-solving, as conceptualized by Skinner, will be analyzed as specifically as possible into particular behaviors, habits to be acquired that are appropriate for college students and suitable for programming on a machine. These specific behavioral objectives of the program will be set forth in the paper referred to in (1) above.

(3) The project director together with a class composed of senior and graduate students in psychology and practicing public school teachers will construct a program designed to teach the behaviors involved in thinking and problem-solving to college students by machine.

(4) An experimental evaluation of the program will be made by comparing the problem-solving performance of two groups of University students, one of which has received instruction in problem-solving by machine, the other by classroom lecture."

2. Summary of research activities.

(a) During the fall semester of 1960, a graduate Special Problems course was offered by the Project Director at the University of Nevada which was devoted to an intensive analysis of Skinner's Verbal Behavior. Five graduate students in Psychology enrolled in the course, the major written assignment for which was to prepare a paper explaining Skinner's position on the nature of thinking in language understandable to the educated layman. At the end of the course, the Project Director himself prepared such a paper in which Skinner's views related to the subject of thinking were set forth in non-technical language.

(b) During the spring semester of 1961, a graduate Special Problems course was offered with the purpose in mind of having the class itself proceed as far as it could in programming a teaching-machine course in thinking and problem-solving, this task to be approached within a consistently Skinnerian conceptual framework. Ten students enrolled in the course, most of whom were practicing teachers or administrators in the local public school system. Of these ten students only two had had previous instruction in Skinnerian psychology, these two having taken the course on Verbal Behavior the preceding semester. The class met for three hours one evening each week throughout the semester.

At the beginning of the course the students read Lumsdaine and Glaser's Source Book to familiarize themselves with the current status of research on teaching machines. Then they studied the paper prepared by the Project Director on Skinner's views concerning the nature of thinking. The Project Director and the class then formulated a working definition of thinking in terms suitable for use in teaching-machine programming. Beginning at this point a record was made of the specific ways in which theoretical issues guided the behavior of the class in constructing the program. Thinking as defined for our purposes was contrasted with the conventional connotations both of "creative thinking" and "problem solving," and a list of behaviors to be strengthened by the program was drawn up. The class and the Project Director then proceeded to prepare sets of frames representative of the three major divisions of the program. Four sets of frames from the first division of the program were checked out and revised on the basis of the performance of an experimental student. Illustrative frames for the second division of the program were prepared by the class, but they were not organized into sets nor were they tried out on sample students. A lengthy set of frames for the third and major part of the program was prepared and given to two experimental students in front of the class on the night of its final meeting.

(c) The summer of 1961 was spent principally in preparing a lengthy Progress Report and in formulating a new grant-application to the U.S. Office of Education which would enable us to realize our objectives in other than a preliminary fashion. Considerable care was taken to provide as thorough a Progress Report as possible at this time, so that the Office of Education would best be able to decide whether or not to continue to support the project. The new application requested a grant of $27,845 to support the project for a period of one-year eight-months, to begin January 1, 1962.

(d) During the fall semester of 1961 the Project Director offered a course open to lower division students in the University entitled "Techniques of Thinking and Problem Solving." It was the intention of the Project Director to use students in this class as experimental subjects in evaluating frames for the thinking-program as it continued to be developed. However, in October 1961 the Project Director was informed that his application for further support from the U.S. Office of Education had been rejected. The Project Director was informed by telephone that the chief reason for rejection appeared to be that the proposed research had been judged to lack generality. In response to the suggestion by the Project Director that in view of the heavily theoretical implications of the research a revised, possibly clearer application be submitted, he was informed that the Office of Education does not support essentially theoretical work. As a result of this information the Project Director felt that the remaining period of the grant could be most profitably spent in preparing a manuscript attempting to explain in some detail various theoretical issues involved in defining and in manipulating thinking when viewed from a Skinnerian perspective.

3. Results and accomplishments.

The accomplishments of this research project with respect to the specific objectives stated above are as follows:

(a) A 41-page paper outlining Skinner's views on the nature of thinking in non-technical language was prepared and submitted in six copies to the U.S. Office of Education as Appendix A of the Progress Report dated July 11, 1961. A copy of the paper is attached to this report. No plans have been made to submit this paper for publication, although approximately 50 copies have been circulated privately in response to specific requests. The material in the paper will be incorporated within a considerably longer manuscript currently in preparation entitled "The Definition and Manipulation of Thought."

(b) The rationale behind the working definition of thinking, the specification of behaviors to be programmed, and the guide to construction of the program were described in a 39-page paper submitted in six copies to the U.S. Office of Education as Appendix B of the Progress Report dated July 11,1961. A copy of these technical and theoretical notes is attached to this report.

(c) Representative frames of that portion of the thinking-program constructed by the experimental class are illustrated in Appendix B of the Progress Report of July 11, 1961 which is attached to this report.

(d) No experimental evaluation of the problem-solving performance of two groups of University students, as anticipated in the 4th objective stated above, was made.

4. Conclusions.

(a) The preliminary research described above suggests that such higher mental processes as thinking and problem-solving are amenable to analysis for purposes of programmed instruction much like other more conventional academic subject matter.

(b) The construction of teaching-machine programs from a Skinnerian point of view involves certain theoretical and technical considerations which can profitably be specified as a rationale underlying the structure of the program.

(c) It seems clear that further effort should be made to ensure a more widespread professional understanding of the implications for programmed instruction of the deeper and more penetrating aspects of Skinner's views concerning the analysis of behavior.

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APPENDIX A

INTRODUCTION FOR THE LAYMAN TO SKINNER'S POSITION ON THE NATURE OF THINKING

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I. GENERAL BACKGROUND

A. INTRODUCTION

A person who is interested in making sense out of Skinner's work probably faces fundamentally only two problems. These two problems differ widely with respect to the difficulty they pose for the uninitiated. Undoubtedly the problem to be considered first in this paper, that associated with something which is to be called mentalism, is apt to present by far the greater difficulty to the reader, the difficulty arising due to the striking uniqueness of the general approach Skinner takes to the study of Nature. The reader is not likely to be prepared to believe that anyone would want to entertain seriously approaching the study of Nature in the particular way that Skinner has made the core of his system. The second problem, which will be discussed here under the heading analytical method, will probably present no particular hardship for the reader; however, he should be prepared to make the effort to learn well the meaning of several new terms which will serve more or less the function of a basic vocabulary.

B. THE PROBLEM OF MENTALISM

The task of the reader for this next section of the paper is to understand what mentalism is, to recognize that the core of Skinner's system is to avoid mentalism wherever possible, to see the sort of things that are involved in studying Nature without mentalism, and to understand why it is that someone might prefer to study Nature in a non-mentalistic way.

What is mentalism? Understanding the answer to this question, "What is mentalism?", is the really difficult job a person faces in making sense of Skinner's work. The reason most people find it hard to grasp what is meant by mentalism is that it represents an attitude about what Nature is and how it should be studied that is so deeply ingrained within the thinking of almost everybody that the idea has never occurred to them that other ways of looking at Nature are even possible. The way in which this paper will approach bringing the reader to an understanding of mentalism is first to describe how it is that most people look at Nature when they try to study it, pointing out those aspects of what has been described that are considered mentalistic. Then this generally mentalistic attitude toward Nature will be sharply contrasted with the non-mentalistic approach taken by Skinner.

1. The mentalistic approach to the study of Nature

Almost everybody is interested, in one way or another, in natural events and what makes them happen. Of course, it is the scientist who is especially interested in the causes of natural events--this in the sense that it is the scientist (it does not make much difference what his field of special interest is) who spends more of his time than anyone else in the study of Nature and of the laws that govern its functioning. It is probably safe to say that most people who are interested in studying Nature, whether they happen to be laymen or scientists, consider themselves as observers to be a part of Nature, and they regard that particular aspect of Nature in which they happen to be interested as another part of Nature, something outside of themselves, which they want to find out about. They tend basically to feel that the other objects besides themselves that exist in Nature and of which Nature is composed are just as real, in a sense, as they themselves are; that no matter how changing these objects of Nature may appear to be, or how complex the events may seem to be in which they play a part, they are basically made up of much smaller elements of Nature that are somehow permanent and stable; that these natural objects and events can stand as suitable subject matter for personal or professional curiosity and inquiry, in the sense that something can be known about them; and, provided that adequate technical skills are available, that the true interrelationships among natural objects and events can be discovered. In short, most people feel, especially in the light of the spectacular material achievements of modern science, that up to a point it is possible to find out how nature really works.

It is this faith that it is possible to know how Nature really works that lies close to the heart of mentalism.

However, to understand specifically what is meant by mentalism requires more subtle considerations. Mentalism involves an attitude that is narrower in scope than the broad faith we hold in our ability to find out, at least to some extent, how it is that Nature is really put together. Mentalism applies only to the attitudes we hold about the _things_ of which we suppose Nature to be composed. Mentalism applies to the faith we have in our being able to identify the actual _elements_ which really make up Nature. Especially relevant to what is involved in mentalism is our faith that once we feel we know what sort of things cause a natural event to come about, no matter how trivial that natural event may appear to be, those things really do exist as part of Nature to cause the natural event to occur. In other words, mentalism is related to the faith we have in our ability correctly to identify the basic units involved in natural functioning. For example, consider a situation in which a ball is observed to rise rapidly in the air after having been hit with considerable force by a baseball bat. Something close to mentalism is involved when we infer that it was the force exerted upon the ball by the bat that caused the ball to rise, _if_ we really do believe that there is such a _thing_ as force, _if_ we believe that the word "force" refers to one of the _real_ units in terms of which Nature is organized, _if_ we believe that what it is that caused the ball to rise in the air is the force applied by the bat and that force is one of the elements into which Nature can _really_ be analyzed.

The preceding paragraph has tried to point out how natural it is for us to believe that the elements into which we analyze Nature for purposes of explanation really are the elements of which Nature is composed. We do not necessarily feel we have identified very precisely or completely the things that bring about the events that take place. However, we do frequently feel that, roughly at least, we are on the right track in trying to explain what happens. It is this faith in our ability little by little to zero in on the things that cause natural events to occur that is closely related to what is referred to by mentalism.

Still, however, our discussion of what it is that is involved in mentalism is much too broad. The term mentalism is restricted to our faith in the reality, as genuine elements of Nature, of the things we call upon to explain the observations we make about living organisms. The term _mentalism_ is most appropriately used in connection with the way in which we try to explain the things that animals and human beings do. Specifically, _we say that a person is mentalizing when he attempts to explain the behavior of an animal or human by reference to objects or events which he feels specify more or less precisely those aspects of Nature which really do cause the behavior to take place_. Thus, just about any explanation of behavior you have ever heard would probably be considered to be mentalistic, if the person speaking were offering the explanation seriously. This is so because most people, when they try to explain any instance of behavior, feel they have at least a possibility of being right, and by being right they mean that the explanation they offered might really be what has happened, that they may possibly have identified, no matter how crudely, at least in rough outline those aspects of Nature which have caused the behavior to take place. The essence of mentalism, then, is the sort of general faith that people have in their ability to guess, more or less accurately, at what the real elements of Nature are that cause behavior to take place the way it does.

It should perhaps be mentioned that the term "mentalism" is often used among non-Skinnerian psychologists in an even more restricted sense than that indicated above, in a restricted sense which reflects more directly the etymology of the word. Often the label "mentalistic" is applied to explanations of behavior which make use of properties of the mind as causes of behavior. For example, it is mentalistic in terms of the way most psychologists use the word, as opposed to the broader use implied by Skinner, to say that a person has spoken because an "idea" popped into his head, or to say that a student studies hard because of "interest," or to say that a person has failed to take a certain course of action because of "fear." "ideas,""interest," or "fear" are generally conceived to be aspects of an individual's private mental world.

As a matter of fact, the explanations of behavior generally offered by non-Skinnerian psychologists who in their opposition to what they call "mentalism" pointedly reject terms referring to objects or events within the mind also turn out to be mentalistic in the sense defined in this paper. For example, most psychologists who would explain the fact that Pavlov's dogs salivate at the sound of a bell by reference to "conditioning" also mentalize because they probably believe that the laws of conditioning are natural laws in the sense that conditioning truly reflects the way Nature works in the control of certain aspects of behavior.

In short, a person mentalizes when he tries to figure out what the causes of behavior really are. He prepares himself to mentalize when he is interested in finding out what human nature is really like.

It is the core of Skinner's system to resist the temptation to mentalize as much as possible. In view of the fact that most persons who take their explanations of behavior seriously probably do so in a mentalistic way, whether they recognize it or not, whether they are laymen or scientists, you are probably wondering how it is possible for someone who is genuinely concerned with trying to make sense out of behavior to avoid the pitfalls of mentalism (whatever they might happen to be).

2. A non-mentalistic approach to behavior

If it is close to the heart of mentalism to study Nature to find out what it is really like, and truly mentalistic to propose hypothetical guesses about the nature of objects or events which influence behavior, Skinner avoids mentalism by restricting his interest in behavior simply to trying to influence it, to do something with behavior, to control it, to manipulate it successfully, or to affect it in some way that can be considered appropriate. Skinner's interest in behavior is intrinsically, fundamentally, and essentially *practical*, as opposed to theoretical, and it is his faith that we can most effectively gain practical knowledge about how successfully to influence behavior by concentrating our attention on the careful and detailed *observation* of behavior as it takes place, our observation in this regard being guided by a conspicuous search for consistencies in behavior that can be directly seen. It is also Skinner's faith that the largest barrier which stands in our way in trying to obtain a practical, working knowledge of behavior is our persistent habit of mentalizing, or trying to theorize about the nature of the factors involved in behavior. Skinner's interest is primarily in trying to *do* something about behavior, and he feels that the most profitable way in which we can approach acquiring the knowledge necessary for this is to spend our time primarily in the *careful*, *direct*, *observation of behavior*, looking for whatever consistencies we can find, and trying to weed out of our thinking whatever temptation there may be to speculate about the real nature of the behavior we are studying.

What it is, then, that Skinner advocates basically is a new way of approaching the study of behavior. In order to look at behavior from a Skinnerian perspective the first thing one has to do is recognize clearly the ultimately practical nature of his interest in behavior. That is, he must keep in mind that in the last analysis the judgment of whether or not his interest in behavior has paid off is to be determined solely on the basis of whether or not he has been able to influence behavior in a manner he considers to be successful for his practical purposes. Thus you can see how different Skinner's interest in the "prediction" of behavior is from that of other social scientists. Most non-Skinnerian psychologists are likely to say that they place high value on predictability as ultimate criterion of the validity of their research. However, when such scientists are successful in making a behavioral prediction, they feel they have acquired further evidence that the particular hypothesis or theory they were testing is likely to be true, to reflect the real order of Nature. Skinnerians, however, do not value the success of their predictions in quite the same way. When a Skinnerian makes a successful prediction, he is satisfied with what he has obtained largely because that was just about all he was interested in anyway as an end in itself, because that is what he set out to do in the first place. If a successful prediction gives the Skinnerian some sort of feeling of his being "on the right track," it's not so much a feeling that he is coming closer to seeing what Nature is really like, as it is that he comes to have a little more confidence in his decision to approach the study of Nature in a non-mentalistic way.

Then, after recognizing the ultimately practical nature of Skinner's interest in behavior, the next step that characterizes the Skinnerian perspective is to keep in mind that one's role in studying behavior is little more than that of observer. The statement, however, that one's role as a Skinnerian is little more than that of observer is double-edged. The statement implies, first, that one has to take the job of being an observer much more seriously than is generally the case with most contemporary psychologists. The average psychologist is perhaps not aware of the fact (in any event he is not particularly worried about the fact) that he actually spends very little time in a direct, observational, scrutiny of his subject matter. Instead, most scientific psychologists make their contribution after having spent a great deal of time in reading about behavior, at best in reading research reports of behavioral experiments actually performed. Then they try to distill this tremendous amount of verbal material, to organize it in some way, trying to spot those areas of professional activity that interest them most and which provide them the greatest intellectual challenge. Then they spend a great deal of time thinking about behavior, trying to formulate more-or-less scientific hypotheses which they can then subject to experimental test. In the end they wind up performing an experiment, thus making an observation. However, in making this observation, they are all too prone to look only at those aspects of the organism's behavior which bear, favorably or unfavorably, upon the hypothesis they are testing. The Skinnerian is much more self-consciously concerned with observing what it is that the behavior he is studying is like. He watches it in very great detail, simply noting as much as he can of what it is the organism is doing. As a result the Skinnerian tends to view the "grain" of behavior in unusually fine detail, as compared with the picture of behavior held by other scientific psychologists.

The other edge of the statement that the role of the Skinnerian is little more than that of observer is that he tries to avoid, of course, the tendency for mentalistic biases to influence his observation. Unlike many psychologists the Skinnerian is careful in his observation to do little more than note the behavior he is studying, to describe it clearly and accurately, not yielding to the temptation to give the behavior premature interpretation.

The next step in following theSkinnerian approach, after recognizing that the knowledge you acquire about behavior is probably going to have to come from your own direct observation, is to look for consistencies in behavior making use of a particular conceptual scheme, using a special set of terms and vocabulary to organize your observations and to enable you to formulate a prediction conveniently. This conceptual scheme, which employs a sharply limited number of terms and concepts, is frequently referred to among Skinnerians as "reinforcement theory," and it is this conceptual scheme which is presented in crude outline in the following section of this paper under the title "analytical method." It is in connection with the particular conceptual scheme that Skinnerians use in their analysis of behavior, "reinforcement theory," that Skinnerians come as close themselves to mentalizing as they will allow. In a sense, "mentalizing" and "theorizing about behavior" mean very much the same thing, and the conceptual scheme employed by Skinnerians is often referred to, as has been stated, as "reinforcement theory." However, Skinner's use of a conceptual scheme dealing with reinforcement, as similar as it may appear to be to mentalizing, is so different from what is generally done by psychologists when they employ "theory" that some have preferred to refer to the conceptual scheme as a system rather than a theory.

It hardly serves any purpose here to quibble about the appropriate word to use in naming something, but it is probably worthwhile contrasting the way in which Skinnerians use their conceptual scheme and the general practice of mentalism as employed by other psychological theorists. The upshot of the matter is this: (1) the system is extremely simple; it is almost "simple minded" in its brevity, (2) Skinnerians use reinforcement theory mainly because they find it enables them to get ideas on how to make predictions of behavior, (3) they do not take the system seriously in the sense that they wonder whether it is right or wrong, or that they are concerned with testing it to find out whether it is true, and (4) they do not take it seriously in the sense that they feel it is an accurate picture of what Nature, in particular human nature, is really like.

There are, however, ways in which it seems simply not the case that Skinnerians do not take their conceptual system "seriously." Of course they do. At times they get unpleasantly deadly-serious about it. It is also undoubtedly the case that when Skinnerians are actually looking at behavior and trying to make sense out of it so that they can make a prediction, they get very excited and feel like they know how human behavior really works, and thus genuinely they mentalize. And yet, who knows, maybe it is human nature to mentalize. To this last sentence the Skinnerian replies, "Who cares what human nature is?", and that is the important thing to understand about Skinner.

I wonder if at this point the reader is now saying to himself, "Well, now!... Hmmmm....So the Skinnerians object to it when others mentalize, but end up doing it themselves. How can they say it's wrong for others to mentalize, but OK when they do it?" The question is a fair one and deserves an answer. As you might expect, what I have to say is that to ask a question of this kind is to involve mentalism pure and simple. "Is mentalism good or is it bad?" you ask. "What really should we do? What is the correct, the accurate, the true, the REAL way to analyze behavior?" This is all mentalism. It is not mentalistic to say, "Who knows the real way to analyze behavior? Not me. But as a human being I have an idea, and I'm going to try it, and if it works then I'll use it because that's what I want."

Yet such an answer is not the full answer that Skinner would give. Skinner would say, if you accept my system, use my concepts, then I can explain in sufficient detail the difference between Skinnerian and non-Skinnerian mentalism. In order to understand Skinner's explanation you would have to study Skinner's Verbal Behavior to the point of thorough understanding. However, the acceptability of such an explanation is contingent upon your willingness to accept Skinner's system, in terms of which his explanation would be given. If you are not willing to accept his system, then he can not explain it very well, and neither can I. If you are not a Skinnerian you probably will react with indignation and say, "To heck, then, with the whole business because it seems at points not to be intellectually consistent." If you have the Skinner attitude, you will react by saying, "Who knows what the nature of 'intellectual consistency' is? Let's just move on and see if we can't do something about behavior." Which of these two alternative courses you choose to take is, after all, very much your own business.

And yet there is a fourth step still, in following Skinner's approach. After a point, it becomes almost second nature for Skinnerians to use their own conceptual scheme to analyze behavior, and they soon find themselves in a situation where they want to make a prediction. At this point the Skinnerian uses his "common sense." In other words he just uses his head to figure out what specific practical predictions seem to follow naturally from the analysis of behavior that he has made. I mention the role that "common sense" plays in the Skinnerian sense for several reasons, most of which are relatively minor. First, the predictions and interpretations which follow from Skinnerian analysis can be said to be arrived at by "common sense," because few people who hold sophisticated notions about mental functions mentalize the term. In other words, "common sense" is not often taken by psychologists to be a genuine psychological entity employed to explain behavior, and to say that predictions follow from "common sense" means that Skinner does not concern himself with the nature of the "real processes" that are "used" in reaching the predictions. Moreover, talking in terms of "common sense" avoids the mentalistic illusion that specific rational processes such as logical reasoning or hypothetico-deductive method are employed in the system to generate the predictions made. The facts of the case seem to be that if you use Skinner's method of analysis in conjunction with the careful observation of behavior, you will not have any trouble ending up with some pretty specific ideas on the practical influences operating to determine the behavior you are studying.

The fifth step, of course, is to be constantly on the look out for hidden mentalism in your appraisal of the behavior you are studying. This means, for all practical purposes, watching to be sure that you do not break behavior up into any parts that you consider to be real units of Nature, human nature or otherwise. This involves the exception, as we have mentioned, of breaking the behavior apart into the small number of different basic concepts employed in Skinner's conceptual scheme.

In short, what is the essence of the Skinnerian approach? It is simply this: In your study of behavior, do not try to find out what the nature of things really is. Simply organize your observations in terms of the small number of concepts employed in the system, and then observe behavior carefully and in great detail.

3. Why approach behavior non-mentalistically?

The reader still, however, probably wonders why it is that anyone would choose to study behavior in the rather strange fashion outlined above, in view of the seemingly more sensible approach that is generally followed. It would seem to most people, including psychologists, the natural thing to do if you are interested in having any practical influence over behavior to try to find out as much as you can about the nature of humans and their behavior and then apply in a practical fashion whatever information you happen to come up with. The Skinnerian approach may seem self-defeating, because it at times appears to shy away from even considering those questions which are clearly the very ones we want to know about, and it encourages simply not paying any attention to the kind of research that is carried out by most psychologists. Why should any one be interested in adopting the rigid and seemingly unnatural restrictions of the Skinnerian approach? The facts are that Skinner's system seems to be having a steadily increasing influence on contemporary psychology and the number of individual psychologists who decide to use Skinner's approach continues to grow. What are the kinds of reasons people give for their having decided to approach the study of behavior in a Skinnerian fashion. A number of the reasons most frequently expressed are simply listed below.

a. Some psychologists are simply discouraged by what they consider to be a lack of real progress on the part of psychology, and they react favorably to the relatively clean break offered by the Skinner system. These psychologists view with despair the seemingly endless theoretical controversy and difference of point of view that marks psychology's apparent contribution to date. Particularly to be mentioned in this regard are experimental psychologists of the more or less "behavioristic" persuasion who have been disappointed in the obvious systematic weaknesses of the major Behavior Theories of the 1940's to which they had looked with so much hope. These psychologists are also apt to look with a sense of dissatisfaction at the significance of the tremendous amount of experimental research on learning, particularly with regard to learning on the part of the rat. What did it all show? These persons also tend to react unfavorably to the common accusation that, for all its show, psychology is still not very much of a science. What is psychology but common sense clouded by technical vocabulary? What, after all, has psychology found out?

b. Then, there are other psychologists, Skinner himself prominently among them in this respect, who are worried about the global social predicament man seems increasingly to be getting himself into, and they are frightened at the pitiful amount of know-how most psychologists end up having. These persons react favorably to the promise of the Skinner system of vastly increased powers of practical control.

c. Most of the psychologists who now follow Skinner's approach probably do so because they have somewhere along the line in their training been exposed to the experimental research undertaken from a Skinnerian standpoint. This is probably a fatal error for the non-believer. It doesn't take very many hours for a person alone in a laboratory with a rat to become very impressed with how interesting behavior is. This conclusion seems unfortunately contingent upon whether or not the person is armed with a Skinnerian lab manual. All too frequently the experimental animals of psychologists continue to stand as ponderous enigmas for the people who use them. Once a man has done some experimental work from a Skinnerian standpoint it is apparently very difficult to adopt a different attitude towards behavior. Not only do these people come to see how interesting behavior is to look at, they get very proud about their ability to make the animal do what they want it to. And this then leads, in conjunction with their continued study of Skinner's writing, to the dangerous but infinitely pleasurable feeling that they actually know something about behavior. They become aware of the fact that they really did not know very much beforehand and the sort of mystery in which behavior seems perpetually to be clouded begins for them to clear up. It is this sort of thing that has gotten most of the Skinnerians.

d. And then finally the extraordinary brilliance of Skinner's published work is very impressive. His work is unusually difficult to understand, this mainly because his perspective is so different from that of other psychologists. The job of really understanding what Skinner has to say is quite a challenge. To some persons Skinner's work has an internal "intellectual consistency" to be found in psychology, at least with the great breadth of scope involved here, only in the writings of James and Freud. It is largely within this category that the basis for this writer's interest is to be found. I personally find what Skinner has to say unusually fascinating from an intellectual standpoint. It seems worth it to take the time necessary to try to make sense out of it. It is something which seems to pay off when you give it serious consideration.

One further comment might be made at this point in closing this section on "General Background." In view of the nonprofessional level at which this paper is being written, the reader might gain the impression that the Skinnerian approach lacks the impersonality, the dignity, the rigor of true science. If this impression has been given it is hardly appropriate. Perhaps more than anywhere else the vigor of the current interest in the Skinnerian approach is to be found in the laboratories of pure psychological basic science. The level of scientific specialization and sophistication associated with Skinnerian experimentation is so high that it is difficult for the general experimental psychologists even to follow the resulting research reports. This paper approaches the introduction to Skinner's system at its most unsophisticated level, since it is intended to provide a background for non-professional people in attempting to program a course for teaching machines at a grossly exploratory level. Skinner himself advocates the gradual technical elaboration of his system at an experimental level, thus providing a more solid basis for use of his system in the prediction and control of human behavior. There is only one way to know what Skinner says and that is to give his work intensive study.

C. ANALYTICAL METHOD

You will recall that the outstanding characteristic of the Skinner system is its emphasis upon the detailed observation and description of behavior, with scrupulous care being taken to avoid mentalism in this. However, it was also stated that Skinnerians use a particular conceptual scheme, "reinforcement theory," to aid them in systematizing their observations and in interpreting them in a form suitable to making practical predictions. In this section of the paper the fundamentals of the particular conceptual scheme used by Skinnerians in their analysis of behavior will be described.

The basic fundamentals of this conceptual scheme are not difficult to grasp, yet a brief word might be said before describing it with respect to rougly how it is used. In many ways, Skinner's conceptual system is like a very simple pair of glasses which the observer wears, and through which he looks, while making his detailed study of behavior. The function of these conceptual glasses, so to speak, is to enable certain crucial aspects of the behavior being observed, and of the social and physical environment in which it occurs, to stand out prominently in focus. This is to say, in other words, that while the Skinnerian is engaged in the observation of behavior, he is especially on the look-out for certain key things, and it is these key aspects of behavior and its associated environment that are matched one-to-one to the major terms and concepts in Skinner's conceptual scheme.

1. The emission of behavior. First, a general assumption. Skinner's whole conceptual scheme is based upon one very broad attitude about the nature of most of the behavior in which anyone is likely to be interested. This attitude involves the notion that behavior is basically emitted by the organism. That is to say, as we look at behavior, or we are in the process of observing behavior, we note that our subject matter has been sent out for us by the animal or human organism in which we are interested. The behavior is simply there. It is there for us to look at, or not to look at, as we wish. Whether or not we as observers want to or are in a position to describe what he is doing, the organism is nevertheless behaving, he is emitting behavior, he is emitting the subject matter which is our object of study.

There may not seem to you to be much value in our making a special point about the obvious fact that behavior is emitted by animals and people; however there are subtleties in this notion which it is important to grasp. In emphasizing the fact that behavior is emitted, Skinner is trying to avoid two problems which arise at the outset in looking at behavior. First, in calling your attention to the fact that behavior is emitted, Skinner is trying to prevent you from thinking that behavior is elicited, or drawn out of the organism, either by the environment or anything else. Behavior is emitted, sent out by the organism, rather than elicited, or drawn out, or evoked, by the external environment. Perhaps you do not think this is a particularly important point to make, but it really is, especially in view of the prevalent ideas about behavior held by most contemporary experimental psychologists. Skinner is primarily concerned, in emphasizing that behavior is not elicited by the environment, in making the point that behavior is not mechanically connected to the environment. Things that happen in an organism's environment do not cause behavior to take place in the sense that they force behavior to come about or make it take place as the functioning of a machine is made to occur as a result of the particular mechanical linkage of its component parts. Organisms are not machines; they are alive, and they do not operate in a mechanical, push-pull, click-click fashion. Skinner takes great care to be very explicit on this point because in his system great attention is paid to the way in which the environment acts to control behavior, and he does not want you to get the idea that the environment exercises any mechanical control over behavior. (It is true that there are certain circumstances when behavior does seem to be mechanically tied to the environment; this is the situation when some environmental stimulus elicits a physiological reflex. However, since true physiological reflexes are rarely a significant part of the behavior we are most likely to be interested in, we will ignore the reflexes in our account here.)

In the reasons we have just given for Skinner's emphasizing the emission of behavior we have emphasized the relation of behavior to its controlling environment, which is said to be non-mechanical. The second reason Skinner emphasizes the fact that behavior is emitted by organisms has to do with the relation between behavior and the emitting organism itself. In stating that behavior is simply emitted, Skinner urges the observer not to mentalize with respect to why the behavior has been emitted, or as to what the cause within the organism was for the behavior's having come about. The starting point for the observation of behavior is the behavior itself. It is simply there. It is inappropriate to mentalize about what caused the behavior to occur, what forced the behavior to be emitted, what it was about the organism that made the behavior come about, more or less mechanically or automatically. If there is nothing about the environment that makes behavior occur, neither is there anything about the organism which forces behavior out of it.

What Skinner is basically doing here is insisting that we not mentalize about the origins of behavior. In a way, it is here that Skinner, very much unlike most other psychologists, recognizes and respects the privacy of the organism. If there are reasons why it is that behavior is emitted in any specific instance, then it is none of our business to speculate about them. The organism simply sends out its behavior, and we start studying it from there. Yet, the temptation to mentalize is pernicious: when we say that behavior is emitted by the organism, we must not mentalize and conceive of the organism as an agent, as something which in and of itself has the power to cause behavior to occur. In particular we must resist the inclination to explain the emission of behavior in terms of any such mentalistic notion as "free-will." Even though emitted behavior turns out generally to be behavior we consider to be "voluntary" (as opposed to the "involuntary" responses brought about when reflexes are elicited), our purposes of describing behavior so that it can be practically manipulated are not furthered by distorting our observations with the patriotic hypothesis that the behavior we are looking at has been basically caused by some agent or mechanism inside the organism, free-will or otherwise. The concept of free-will has its obvious value and advantages in many aspects of contemporary social functioning, but the mentalism it necessarily involves can only cloud the precision of our task here, which is one of direct observation.

Look, over there is an organism doing something. Why can't we just observe it closely and see if we can't find some consistency in what it is doing. Let's just start with the fact that its behavior has been emitted; let's accept the fact, not ask any questions about it, and proceed from there.

2. Reinforcement

Although it is important to understand what Skinner is driving at in pointing out the emissive nature of behavior, an even more central notion in the Skinnerian system is the principle of reinforcement. The Principle of Reinforcement states that emitted behavior is tightly related to its consequences. In the Principle of Reinforcement Skinner urges you to attend, in your observation of behavior, to the specific way in which behavior can be seen to have some effect upon its environment. The first thing that one does, in trying to make sense out of an observed segment of emitted behavior is to look for the consequences that the behavior has upon its environment. Thus, the basic thing that one looks for in studying behavior is some kind of connection, some kind of contingency, between a specific instance of behavior and the effects it has upon the organism's world.

Another way of looking at what is involved in the Principle of Reinforcement should make the concept easier to understand, since it will reveal that the Principle of Reinforcement involves nothing that is fundamentally strange or new to your own experience. One of the things Skinner is doing in stating the Principle of Reinforcement is simply calling your attention to the clearly adaptive nature of most behavior. In a sense, most of what it is that people do, and animals as well, for that matter, produces some sort of result, some sort of effect, upon the environment, and it is the fundamental notion of the

Skinner system that most of the job of explaining behavior, or of making sense of it, is to be done by simply observing the adaptive effect that the behavior can be seen to have as far as the organism is concerned. In other words, for example, the first step that a Skinnerian would take in trying to make sense out of the fact that a particular chicken is observed to cross a particular road, is to consider in what respect crossing the road has changed the environment of that specific chicken so that it is now in a position to adapt more successfully to the general environment in which it finds itself.

There is probably little in what has been said so far about the Principle of Reinforcement that is apt to strike the reader as particularly different or even unreasonable, as far as his own practices of making sense out of behavior are concerned. However, the proper use of the Principle of Reinforcement does actually offer something new to the reader in view of the fact that he probably has available to him a well established and extensive set of mentalistic terms in mind which he habitually calls upon to identify the varieties of "purposes" of behavior. Chickens may possibly be thought to cross the road because they "want" to get to the other side. A student reads a particular book because he is "interested" in what it has to say, or because he finds it "rewarding" in some more or less practical way to read it. Obviously this kind of "mind-reading" of behavior is not going to be consistent with the stringent anti-mentalism of the Skinner system.

How is it, then, that we are to look for relationships between behavior that has been emitted and its adaptive consequences for the organism, without mentalizing about the kinds of purposes for which the behavior was emitted? The answer to this question constitutes the most famous, and in many ways the most central, contribution of the Skinnerian approach. What we do, in essence, is to state that we observe a relationship between the emitted behavior and some change in the organisms' environment, no more, no less. What we do, as the net result of our observation, is simply to describe two things: (1) the particular piece of behavior in which we happen to be interested, and (2) the particular way in which the environment has changed, more or less directly as a result of the behavior. Said another way, basically what we are doing in studying behavior is looking at it in such a way that will enable us simply to describe two things, the behavior itself, and whatever environmental changes follow as a consequence of it. This sort of thing is the essence of what we are fundamentally trying to do in our observation: to look at behavior as we see it, and to look at the environmental changes that follow as a result of it, very much as we see that, too. We have no mentalism here, if we try to study behavior with this kind of attitude in mind. What is involved here is no more than two very simple steps: first, we simply observe the behavior; and then secondly, we do no more than describe on the one hand the behavior itself and on the other hand the environmental changes which follow from the behavior.

What we have said, in short, is that the first fundamental objective of the Skinnerian method of analysis is simply to describe observable contingencies or connections between behavior and its environmental consequences. Perhaps a bit of diagramming would make things simpler still. Psychologists have long made use of the practice of referring to observable changes in behavior as responses, which we can identify in a diagram by the letter R. Similarly, observable changes in the environment are called stimuli, conventionally represented by the letter S. If we let S^R stand for "reinforcing stimulus", the kind of connection between behavior and the environment in which we are interested can be diagrammed like this.

$$R \longrightarrow S^R$$

Skinner makes a practice of calling observed relations between the environment and behavior functional relations, so that another way of stating the point we have been trying to make would be to say that the primary objective of the Skinner system is to make a functional analysis of behavior, in which we are particularly interested in observing relations between specific responses and the particular reinforcing stimuli which follow then. The specific stimuli to which behavior is related in a functional relation are often referred to as the behavior's "controlling variables." The arrow --> in the preceding diagram obviously means something very simple like "is followed by."

Now let's stop for a moment. I have a feeling at this point you might be beginning to wonder where this is all going to get us, is all this talk about careful distinctions between observable responses and objectively describable changes in the environment really worth it. Or perhaps it might be closer to what you are wondering to ask, but isn't this way of looking at behavior much too artificial, too arbitrary? That is, aren't we leaving the really important things out, the more or less psychological things? It may seem to you foolish to expect a way of looking at behavior which simply concentrates on describing the environmental consequences of behavior to be of much value in enabling us to understand behavior. Or you might recognize the implicit mentalism of fearing that Skinner's approach does not seem to be heading in a direction to enable us really to learn about behavior, while at the same time reacting with considerable doubt that such an arbitrary approach could lead to much information that would be practically useful in influencing behavior. My reply at this point to questions of this kind would be to remind you that after all the proof of a pudding is in the eating of it, and the facts are that people who look at behavior in the Skinnerian fashion seem to find it increasingly profitable to do so. But perhaps it would be of more help to call back to your attention what it is that we are basically concerned with, namely, that we are turning to Skinner's system in the hope that it will enable us to be more successful in our efforts to influence behavior to do something about behavior, to have some practical effect upon specific human behavior patterns. With this as our ultimate goal clearly in mind, look again at our basic diagram: $R \longrightarrow S^R$. This relationship, which is the object of fundamental interest in our observation of behavior, involves an association between only two terms, behavior and external environment. If we ever were, actually, to have any influence upon behavior, to control it or to manipulate it successfully in any way, what is the only thing we have to work with in trying to influence it? And I mean the only thing. All we can do, no matter how hard we try, is to manipulate some aspect of the environment, more or less trusting in its efficacy in influencing the behavior. If a person ever started out to influence the behavior of another person, he would necessarily, almost by definition, end up having to do something, and in the doing of it basically what would happen is that he would change the other person's environment in some way. Thus it is more appropriate for you to be encouraged, rather than discouraged, in seeing the Skinner system setting up connections between behavior and the directly observable environment, that is if you are really serious about your interest in doing something which you hope will have a substantial effect on someone else's behavior.

But let us return again to additional, more subtle, aspects of the Principle of Reinforcement. The Principle of Reinforcement does not apply to the association between an emitted response and just any environmental change you happen to observe to follow the behavior. Only certain of the observed relations between behavior and environmental changes which follow are of interest in the analysis of behavior. In particular, we are interested only in those environmental events which take place subsequent to behavior which can appropriately be named reinforcing events. Skinner's method of analysis makes use of a conceptual system often referred to as "reinforcement theory," and it is general English usage to mean by "reinforcing," something which is strengthening. What does it mean to say that a particular stimulus, a particular environmental change, which follows behavior, is reinforcing?

Answering this question means basically only narrowing down a little bit the range of the behavior, environmental-change relationships that we look for in observing behavior. If you, as an observer, watch behavior closely enough you will see that there are certain environmental events, certain stimuli, which when they follow an emitted response are observed to be associated with an increase in the frequency with which the response is emitted from then on. In other words, if you watch behavior a little bit more closely, and quite a bit more persistently, than is generally the case with most people, you will soon enough discover that whenever certain particular environmental events occur you can predict fairly securely that whatever response the organism emitted just prior to the occurrence of the event will soon be emitted by the organism again. That is, it will look like the occurrence of the event strengthened the tendency of the organism to emit the immediately prior response. It is this class of environmental change that is said to be reinforcing; it is to the class of functional relations made up of responses followed by stimuli which strengthen these responses that the Principle of Reinforcement applies; and it is to the search for such relations between reinforcing stimuli and prior emitted behavior that our observation is basically directed. Once again, what is a reinforcing stimulus? It is any environmental change which is observed to be associated with an increase in the frequency with which behavior emitted just prior to it occurs from then on. Hopefully, the reader will appreciate that in our stating that it is possible to observe situations which are associated with an increase in the frequency with which a specific piece of behavior will occur we are very much on the track where we want to be, if we are seriously interested in having any effect upon behavior ourselves. Such stimuli, reinforcing stimuli, are in a sense all we need to have, since we know that when they occur they are followed by an increase in the frequency with which the immediately preceding behavior is emitted. That is, one way in which we ourselves can directly influence behavior is simply to arrange for a reinforcing situation to occur immediately following the specific responses we wish to strengthen. There we are. Perhaps it is now also apparent why it is desirable to define reinforcing stimuli in terms of directly observable environmental changes. Influencing behavior becomes something manageable, something feasible in a practical sense, if basically what we have to do is direct our thinking towards how to manipulate the physical environment in a desired direction.

I think we had better slow down a bit, in view of the suddenness with which we have found ourselves to be very much exactly at the point we wanted to reach. Now wait. Actually nothing has been said which is really very startling. What did we do? First your attention was called to a particular kind of fact, namely, that if you put yourself in a position where you can really observe behavior carefully you will sooner or later see that there are certain events which occur and are followed by an increase in the frequency of the behavior emitted just previously. This by the way is fact, not theory. Make the observations on your own and see for yourself. Then we simply named this particular class of environmental event: reinforcing stimulus. Finally we went on to point out that if we can manage to gain enough control over the physical environment to arrange for those events we have observed to be reinforcing to come about at the time we want them to, then we have a means of doing something practical about influencing behavior. That is all.

If you find that this idea still disturbs you, the chances are ninety-nine in a hundred that the trouble is the particular way you are mentalizing the concept of reinforcement. There is no need for you to mentalize "reinforcement;" in fact, it is extremely inappropriate for you to do so. How do most people mentalize the term? For example, they can feel that there is something about reinforcing stimuli that has the "power" to control behavior or to change it. Or they suspect that as they observe the frequencies of emitted behavior to change in a fairly predictable fashion they feel that some "thing," some part of the organism or of its mind has been strengthened or weakened, as possibly a muscle might be. Or again, they might feel that reinforcing stimuli have some inherent property which the organism "wants" or "values" in some way. I know it is difficult not to mentalize the concepts we use to explain or to understand natural phenomena, but particularly with reference to Skinner's work it is much better not to do so. In particular, if you can avoid mentalizing the concept of reinforcement then you will not be so tempted to read into the system things that really are not there.

If it is any comfort to you I might add that it is by no means an easy thing to describe the properties of the reinforcing events we can observe in connection with a great deal of human behavior, and quite a bit even more difficult is the job of manipulating the human environment in a way we might find to our material advantage. On the other hand, lest you become too discouraged at the obvious difficulties involved in the practical control of human behavior, let me point out that it is a matter of very little difficulty to control the behavior of some less privileged animal, like the laboratory rat or the pigeon, where there are few social restrictions upon the control we can exert over their environment. In fact, Skinner's skill at "animal training," for example, teaching pigeons to play ping-pong or to guide an armed missile on target, is very spectacular.

Perhaps, finally, a few words should be said about what sort of events are frequently observed to be reinforcing. Of course, any such question as "What is the nature of reinforcement?" is way out of line for its obvious mentalism. What you have to do is simply to describe those classes of events which can be observed to be reinforcing. For example, the reinforcers most frequently used in animal studies can be referred to conveniently under some such label as "biological." If a rat or pigeon is deprived of the opportunity to eat for a while, food becomes a reinforcer that is very convenient to use. Similarly, for animals deprived of liquid for a period, water is a good reinforcer. With respect to humans, Skinner in a weak moment listed a number of general terms which classify rather complex environmental events which seem to be effective in controlling human behavior: "approval," "affection," "submissiveness," the opportunity to manipulate one's environment successfully, tokens such as money and grades in school, "attention," etc. (The moment was a weak one for Skinner, for he was surely conscious of how deeply most people would mentalize these terms.) However, much more significant is the distinction Skinner makes between two basic classes of reinforcers: positive and negative reinforcers. Actually the distinction between positive and negative reinforcers is simply made, and it involves only paying attention to one aspect of the environmental change which constitutes the reinforcement. If the reinforcing change involves the conspicuous addition of something new in the organism's environment, the reinforcer is said to be positive. For example, positive reinforcement is involved in strengthening the behavior of an experimental animal by suddenly presenting food when the desired response is emitted, or in strengthening the verbal behavior of a cheery "hello" by smiling. On the other hand, negative reinforcement is involved when an experimental rat learns to step on a pedal to turn off an electric shock, or when the behavior of apologizing is strengthened by the disappearance of an angry frown. Negative reinforcement is an important concept in explaining human behavior, for Skinner has pointed out how much of the social behavior of most people is maintained in strength largely because it is successful in avoiding trouble.

If reinforcement strengthens behavior, what weakens it? Skinner has called our attention to the following important fact: when a response that has in the past been followed by reinforcement is no longer reinforced, the frequency with which the behavior is emitted drops to a very low value. This fact is called extinction. One should not get the mentalistic idea that when reinforcement is withheld some sort of habit gets "extinguished," much in the manner in which fires get put out. Extinction refers to what it is that is observed when what has been a reinforcing event no longer follows an emitted response: the frequency of emission of the response simply goes down.

3. Discrimination

As brief as the foregoing material has been in view of the central importance the Principle of Reinforcement plays in the Skinner system, it has been far too long for the purpose it is to serve in this introductory paper. There remains, however, one other major topic which must be introduced before our job can be considered complete. Very much as important in the practical analysis of behavior as the two-term contingency between response and reinforcement ($R \dashrightarrow S^R$) discussed above is the three-term contingency $S^D \rightarrow R \rightarrow S^R$ involved in the Skinnerian concept of discrimination.

It was the point of the preceding section on Reinforcement to emphasize that the main things one looks for in the observation of behavior are circumstances in which specific changes in the organism's environment are associated with an increase in the frequency of the particular response which precedes them. However, this observation that organisms emit more frequently responses that are reinforced should not be taken to imply that behavior is emitted essentially independently of prior stimulation. As a general rule, behavior in most practical circumstances is emitted under the constant guidance of preliminary stimulation which so to speak sets the stage for response-emission to be followed by reinforcement. Environmental objects or events (stimuli) which characteristically precede the emission of responses followed by reinforcement are known as discriminative stimuli (written as S^D in a behavioral diagram).

I am very much afraid that the exposition in this paper is becoming about now so technical that the reader may be tempted to despair of making much of any sense at all of the rudiments of Skinner's system. But let me encourage the reader to persevere for just a few pages more, for the concept of discriminative stimulation is the last major technical term to be introduced in this discussion.

Technically speaking, S^D, or discriminative stimuli, are said to "set the occasion" for an emitted response to be followed by reinforcement. What exactly does this mean? Let us get back to the more comfortable situation where we are simply engaged in the detailed observation of behavior.

Once again, specifically what is it that we are doing? Let us imagine that we are occupied for a period of time solely with the task of watching what it is that an animal is doing, of noting in detail the characteristics of its behavior and of the specific environment in which it takes place. As we have pointed out before, we are apt from time to time to observe, upon continued scrutiny, instances in which reinforcement occurs; the environment changes and the frequency with which a specific response is emitted increases. However, if we are now to concentrate our attention only upon those specific occasions where reinforcement is taking place, more often than not we would be likely to observe an additional characteristic of the situation. As a general rule we would observe that these reinforced responses are emitted only when some special property of the environment is present. For example, let us say that we have observed that a particular cat of our acquaintance is regularly reinforced with food after emitting a series of loud meows soon after entering the kitchen. However, do we also observe that every time the cat happens to enter the kitchen it starts letting out the loud meows? Certainly not. There are many circumstances in which the cat can be seen to enter the kitchen and remain there relatively silently. For one thing, the cat may just have finished eating its full, in which case meowing is less likely to occur than if it has not eaten in some time. But more specifically, in view of the example of discriminative stimulation we are giving, it is not particularly likely that the cat will emit its protracted meowing if it can see that the dish where it is normally fed is already filled with food. In this case it will probably simply approach the dish straight away and eat. On the other hand, if the cat enters the kitchen and there happens not to be any food in its dish, then the situation is nicely set up for the meowing to occur. But our point: clearly the likelihood that our cat will emit the behavior of loud meowing in the kitchen is related to whether or not there is food in its dish. If such is observed to be the case we would identify the control over the meowing exercised by the presence or absence of food in its dish as a relation of discrimination. In the situation we have just described, the presence of food in the dish is a discriminative stimulus which sets the occasion for the cat's emitting the response of approaching the food and eating.

On the other hand, the empty dish constitutes an S^D for emitting the meows.

Let me cite another example, this time involving S^D's for human behavior in a situation which is especially clearly packed with discriminative stimulation. Consider the situation normally to be observed in a simple, but typical, speech episode. You are walking down the street and you catch sight of a well-liked friend just a short distance away. You cry out, "Hello there, John," (So far, the appearance of your friend presented an S^D for your emitting the verbal greeting.) John in turn looks up, and responds, "Oh, hello, Mac," or whatever it is. (John's looking up and responding verbally are clearly related to the discriminative stimulation provided by the sound of your voice.) You in turn broaden your smile (the S^D is John's friendly response) and so on. In short, most of the verbal stimulation to which we respond in our daily affairs constitutes S^D of one sort or another.

In all probability you can see from the above illustrations that there is nothing particularly difficult about the concept of discriminative stimulation. You can also probably see that one would not get very far in describing the consistencies that can be observed to be inherent within behavior without making heavy use of the concept of discriminative stimuli.

In concluding this section on discrimination it might be appropriate to try to give you some idea of the range of other Skinnerian concepts which are being left out of this introductory account. Actually, in spite of the tremendous detail into which typical behavior situations are currently being analyzed by Skinnerians in the laboratory, only a small number of additional fundamental concepts would be needed to make our survey of the basics of the system complete. At its heart, the Skinner system is a technique for analyzing the relations between behavior and its controlling environment, and we have already touched upon the two major functions that environmental stimuli can serve in relation to behavior, at least in terms of the Skinnerian approach. These two stimulus functions are, of course, reinforcement and discrimination: S^R and S^D.

Very briefly mentioned somewhere back there was another stimulus function, elicitation, as in the case where physiological reflex responses are called forth by appropriate external stimulation. There remain only two other major stimulus functions that could be described. However, in spite of the fact that they play an important role when the job is faced of trying to account for just about any type of behavior that can occur, they will not be discussed here since their importance in human critical and creative thinking is relatively small. However, just for the sake of satisfying your curiosity I will state the names of these two other stimulus functions at this point. In addition to the reinforcing, discriminative, and eliciting function that the environment can have in its relation to behavior, complex changes in the environment can also be observed (1) to arouse emotional behavior and (2) to alter the motivational state of the organism through biological deprivation.

4. Concluding overview

Let us try to put what we have said so far into some sort of unified picture of behavior before moving on to a consideration of the kinds of things Skinner has to say about human thinking. What, after all, does a human being look like to someone who does little more than to note the consistencies in his behavior, taking advantage of the Skinnerian conceptual scheme?

It is in a sense very important that you have a clear perception of how vividly human beings come to assume a particular form, to appear in a unique light, if they are viewed through the conceptual "glasses" which comprise the Skinner system. If you are a Skinnerian, and spend a great deal of your time as you must simply observing, watching and describing behavior, it is truly remarkable how striking you find the particular picture which human beings seem to present. The business of avoiding mentalism becomes fairly automatic after you practice it for a while, and it is at this point that humans come to appear very clearly as they do to Skinnerians.

People come to look very simply like a big bundle of specific responses more or less loosely strung together on a single frame. Whenever the individual does anything, the event takes place as a sort of spontaneous emission of a very particularized piece of behavior. And yet there is no flavor of unpredictability about the emissive quality of/this behaving, such as the term spontaneity might suggest. The individual appears to be running very much on some sort of a schedule, a nicely timed and precisely regulated schedule which is kept smoothly running by the particular way in which the environment happens to be changing. The sense of power of the discriminative control exercized by the environment over behavior is very strong. The individual is seen as constantly changing its patterns of behavior in neat adjustment to the minute changes that constantly occur in his surrounding world. One is not particularly conscious of the power of reinforcement, and yet he is led by the beauty of the conceptual scheme to be aware of the tremendous extent to which reinforcement must have been operating in the past to establish the particular behaviors and to maintain them in current strength. One also all too often, unfortunately, views the picture of the behaving human organism with a slight sense of sadness, because he becomes very conscious of how much of our behavior is maintained in strength because it enables us to keep certain kinds of stimulation out of our environment. However, this feeling of sadness is generally compensated for by the impulse to marvel at how fantastically efficient the organism is in maintaining such a flexible adaptability in the face of the constant change in natural environmental events.

I have tried to paint this picture of what humans look like to Skinnerians because in order to make sense out of the specific behavioral analyses that Skinnerians make, two further points should be offered the reader, more or less by way of advice.

a. First, try to remember that the "grain" of behavior is small. When you view the world as a Skinnerian you are apt to become conscious of how far off the track most people are in what they pay attention to in simply trying to observe and describe behavior as it occurs. It is impossible to observe behavior without paying attention to certain specific aspects of what is going on, without attending to certain "things" about the behavior, without breaking it in the act of observation into some sort of parts or units. As a rule, of course, these parts or units into which behavior is broken in observation are mentalized, but my quarrel here is not with the practice of mentalizing them, with respect to which enough has already been said. Now I am interested in calling your attention to the fact that for most people under most circumstances these parts or units are too big, too gross. Before much practical control over behavior can be exercised, it is necessary to become aware of how the gross behavior pattern can be broken down into component parts, each one of which is separately maintained by specific discriminative and reinforcing stimuli. The consistencies involved in the control of even an apparently simple piece of behavior like putting out a cigarette in a handy ashtray actually can be seen to constitute a fairly complex chain of smaller behaviors, the separate parts of which are stuck together by a corresponding series of discriminative and reinforcing events. Skinner is sometimes criticized for basing his analysis of human behavior on experimental study of no more than the simple act of a rat pressing a lever in a small box to get food. Actually, however, the "act" of bar-pressing is a relatively complex one, which can be established in an experimental animal efficiently only by detailed inspection of the component parts of the chain.

b. Secondly, try to keep in mind that in analyzing behavior from a Skinnerian standpoint we are looking at the organism in only one way, as only one type of thing: a complex set of specific behaviors, a large collection of specific movements the organism can emit, an extremely extensive repertoire of responses. The phrase "response repertoire" is Skinnerian, and it refers to the collection of specific things that a given animal or individual can do, to the vocabulary of specific behaviors that have been strengthened by reinforcement and thus are possible for him to emit. In other words, you must try very hard to keep this picture of the individual as simply a repertory of responses foremost in your mind in attempting the analysis of behavior. There are a large number of other, and at times possibly more interesting, pictures or frames of reference you could use in relating yourself to human beings, and undoubtedly you are well practiced in calling upon these different perspectives as the appropriate occasion demands. However, please try to remember that they are irrelevant to our purposes here. It is certainly not the case that these other perspectives towards humans and their nature are in any sense "wrong" or "ill-advised." Even the most rabid Skinnerian will concede their adaptive nature in special circumstances. And for my part, I should like to emphasize that the method of analysis we are developing here should in no sense be considered as "right" or "true." I do, however, recommend the system for its practical utility and its inherent interest value. My only point is that if you aspire to the practical advantages that the system claims, be sure to use the system consistently and completely. Let us consider now what Skinner has to say about thinking.

II. SKINNER ON HUMAN THINKING

You might be interested, in view of all we have had to say so far in this paper, to read a little bit of what Skinner has to say. The following quotations which will serve very well the purpose of summarizing in advance the essence of Skinner's position with respect to thinking, are taken from the last chapter of his important work Verbal Behavior. The title of this last chapter, by the way, is very simply "Thinking."

> The simplest and most satisfactory view is that thought is simply behavior--verbal or non-verbal, covert or overt. It is not some mysterious process responsible for behavior but the very behavior itself in all the complexity of its controlling relations, with respect to both man the behaver and the environment in which he lives....
>
> Tradition and expedience seem to agree in confining the analysis of human thought to emitted behavior generated and maintained by the contingencies of reinforcement in a given environment. So conceived, thought is not a mystical cause or precursor of action, or an inaccessible ritual, but action itself, subject to analysis with the concepts and techniques of the natural sciences, and ultimately to be accounted for in terms of controlling variables.
>
> The emphasis upon controlling variables is important. A practical consequence is that such a scientific account implies a technology. There is no reason why methods of thinking and of teaching of thinking cannot be analyzed and made more effective. But there is a more immediate theoretical issue. Nothing is gained by regarding thought as behavior in the sense of a mere form of action. We cannot move very far in the study of behavior apart from the circumstances under which it occurs....

> For example, Shakespeare's thought was his behavior with respect to his extremely complex environment. We do not, of course, have an adequate record of it in that sense. We have almost no independent information about the environment and cannot infer much about it from the works themselves. In discussing Shakespeare's thought, then, we merely guess at a plausible set of circumstances or deal with our own behavior in responding to the works. This is not very satisfactory, but we cannot improve the situation by identifying thought with mere form of behavior....
>
> This concern with form has left the study of the content of thought in an unsatisfactory state, but the "facts," "propositions," and other "referents of statements" find an adequate representation among our controlling variables. The functional relations between behavior and the environment are usually complex and very often confusing, but we are not in doubt as to their dimensions or the techniques with which they may be studied. We can disregard the troublesome dissection of human thought into the familiar pattern of (1) a man possessing (2) knowledge of (3) a world. Men are part of the world, and they interact with other parts of it, including other men, as their behavior changes, they may interact more effectively, gaining control and power. Their "knowledge" is their behavior with respect to themselves and the rest of the world can be studied as such....
>
> It is a salutary consequence of this point of view to accept the fact that the thoughts of great men are inaccessible to us today. When we study great works, we study the effect upon us of surviving records of the behavior of men. It is our behavior with respect to such records which we observe; we study our thought, not theirs. Fortunately, the contemporary thinker can be subjected to a different kind of analysis. So far as a science of behavior is concerned, Man Thinking is simply Man Behaving.

That is Skinner; and I might add that, in my opinion, it is magnificent Skinner. The chances seem to me high, however, that the reader is likely to have reacted with some disappointment to the passages I have quoted above. All we have to do is to look just a little bit more closely at exactly what it is that Skinner is saying.

The essence of Skinner's idea is that thought is simply behavior. We are given a clue that what it is Skinner is driving at is more subtle than what the rather bland statement "thought is behavior" seems at first glance to state in the fact that the word behavior has been stressed with italics. We shall return to what Skinner is trying to get across by italicizing the word behavior in a moment, for it is his main idea. But first, however, let us examine the implications of the statement, which is important enough in its own right, that "thought is behavior." Leave out the italics.

By taking a position that thought is behavior Skinner is making it quite clear that little is to be gained by mentalizing the concept "thought." Skinner is stating that whatever practical advantage with respect to controlling behavior follows from using his direct-observational, non-mentalistic method of analysis of behavior will simply be lost if we try to understand human behavior in terms of a mentalized "thinking process." This means, in other words, that we should not look at thinking as a process, as some thing going on in the "mind," as the exercise of a special faculty of the mind or brain, as the use of any supposedly uniquely human capacity for logical reasoning, or anything else like this. It is his point instead that if we want to do anything about the way people think, to help train them to think more effectively, to encourage them to do more thinking under certain circumstances, to "teach people to think" as in the presumption of our teaching machine program, or whatever, thinking must be conceptualized as specific things that people do, as behavior, and then subjected to much the same kind of analysis that he advocates for any other "type" of behavior. If the word "thinking" has any consistent meaning for people who use the term in speech, as it undoubtedly does, then it must refer to specific types of behavior which people must sooner or later agree about as involving thinking. Anything that can stand for whatever it is that thinking refers to, if the term "thinking" is understandable to someone else, must at some time be based upon something that it can be seen that people do. And if what it is that thinking refers to can be seen by others to be done, then it must be closely related to behavior, and it is to these behaviors that Skinner directs our attention. Thus to say that thought is behavior means two things: (1) that "thinking" must refer to something that we can observe people to do, and is thus behavior and (2) that thought is subject to the same kind of analysis that Skinner applies to any behavior.

But, you object, not all thinking is behavior in the sense that some one else can observe you do it. Much thinking is observed to take place only by the individual engaged in it. It is simply not the case that all thought is directly reflected in observable behavior. This is true, and Skinner recognizes this fact. Not all behavior is overt, or publicly observable. In *Verbal Behavior* and in other writings Skinner describes how it is that his system can be extended to include private events, functional relations which only the individual himself can directly observe. The problem of making sense out of private events through the techniques available to a natural science is aggravated by the difficulties we face in trying to teach people to talk about their subjective experience, but no new problems are presented by having to deal with subject matter of a special kind (private as opposed to public events). At any rate the Skinnerian treatment of this problem is quite sophisticated, and it will turn out not to be necessary for us to go further into the matter to do the specific job we have set out for us.

And yet let me call your attention to the difficulties involved in making sense out of the statement *thought is behavior* without mentalizing, and Skinner's remark is made thoroughly without this error. That is, when you consider the proposition "thought is behavior," you probably understand it to mean that thought is a particular *kind* of behavior. This is very much what Skinner does *not* mean. To view thinking as some special kind of behavior (Skinner uses the phrase *form* of behavior) such as covert speech, or verbal behavior reinforced by the speaker himself, or any other special way of transforming "thinking" into behavioristic language is simply to mentalize *behavior*, to substitute one form of mentalism for another, to refuse to mentalize something which cannot be publicly seen in favor of mentalizing something that can. In short, the main implication of the simple statement that thought is behavior is little more than the fact that what it is that is commonly referred to by "thinking" can be conveniently and profitably analyzed by applying the Skinnerian method of behavior analysis here as well as to any other sample of behavior in which one is interested.

(I feel at this point compelled to comment on my own considerable dissatisfaction with what I have had to say so far about "the meaning of the simple statement 'thought is behavior'." My dissatisfaction arises due to the fact that in the paragraphs above there are ways in which I have set up a straw man for my own purposes and more or less self-consciously knocked him down. I consider my argument so far to have been directed towards a straw man because in Skinner's treatment of thinking he has not actually specifically made the points I have tried to bring out above. You are probably prepared to forgive me for the liberty I have taken, because it reflects my interest in trying to help you avoid, as reader, certain pitfalls which I consider it very likely you would encounter in trying to approach the subject of thinking in a Skinnerian fashion. Frankly, the main thing that offends me about what I have said is the flagrantly mentalistic language I have used in making my point. So I am anxious at this point to move on to what it is that Skinner really has to say about thinking.)

As I have implied before I view Skinner's conceptualization of the problem of human thinking to be a singularly beautiful intellectual achievement. Let us review again, literally, the essence of what Skinner has to say: "Thought is simply behavior--verbal or nonverbal, covert or overt." At first glance the statement sounds clearly nonsensical. Anything a person does, verbal or nonverbal, covert or overt, is thinking. How is it that Skinner can possibly mean what he says? Let us review the steps that Skinner has taken which lead him to make this statement.

First, Skinner has recognized that the origins of our concern with the problem of human thinking actually lie in the verbal behavior of many relatively sophisticated individuals who live their lives as members of a verbal community which can loosely be identified under the label "Western civilization." That statement probably doesn't mean very much to you, so let me state what I have said again in other words. If we look, as proper Skinnerians, at the actual behavior in which we are interested, namely the behavior of being concerned with the characteristics of human thinking, the first thing we can observe is that the behavior of being interested in thinking exists as a matter of existential fact as a small part of the totality of verbal behavior in which we members of Western civilization engage; that is, it exists as certain specific statements actually spoken or written, heard or read. In other words, what it is that we actually have to deal with in considering the problem of thinking is a specific set of statements emitted by people as part of their verbal behavior.

Let's start over again. What is thinking? Well, I don't know what thinking "is"; to hold any idea about what thinking "is" would be to mentalize. But even though I'm not willing to make any statement about the nature of thinking, I can tell you one thing about "thinking": It's a subject of conversation. People sure do talk a lot about "thinking," and if I look at the way they talk about it, I gather that they feel it's a pretty important quality for people to have, and I also gather that most people feel they have some idea on what constitutes thinking.

The paragraph I have just written is probably, for all its crudity, fairly clear. What it says in short is that we can start our analysis of thinking with the observation that our subject matter actually exists as a small part of genuinely observable verbal behavior. Or said another way: we can solve our problem of thinking by solving what it is that people are talking about when they mention thinking (to put it mentalistically), or we can solve our problem of thinking by describing the variety of discriminative stimuli which set the occasion for verbal responses containing the word "thinking" (to put it non-mentalistically).

Let me try just one more time. You're interested in thinking, are you? How do I know? Well, I observed your emitting verbal responses involving the word "thinking." For example, you just read the word. I also observe that a lot of other people besides you are interested in thinking. Fine. Let's study thinking What are we going to look at while we do it? Well, we are going to look at the variety of situations which make it appropriate for people to emit the word "thinking." In other words, our subject matter, "thinking," is defined here for purposes of analysis as whatever S^D set the occasion for verbal responses related to "thinking."

In short, in studying thinking, what we are really going to end up looking at, is what sort of natural events lead people to talk about thinking. Let's get comfortable again and mentalize. In other words, our first step in analyzing thinking is simply to describe what sort of things people mean by thinking.

This is exactly what Skinner proceeds to do. He bends over backwards in the last chapter of Verbal Behavior to try to be helpful in considering human thinking, but he recognizes that the word thinking is used by many different people in many different ways and in greatly differing circumstances. He also recognizes that he is concerned with explaining whatever behavior people are talking about when they use the term. So Skinner proceeds, in one of his books, to classify several different types of behavior which people refer to in using the word thinking. In making this classification, all he is trying to do is to narrow down the field to that particular area which is the real psychological challenge to explain. For example, he eliminates such usages of the word "thinking" as in the statements (1) "What are you doing?" "Oh, nothing, just thinking," and (2) "I think I'm going to be sick," and (3) "Oh, why don't you think about what you're doing," and so on. In this particular book to which I'm referring, Science and Human Behavior, Skinner concentrates upon thinking in the sense that reference is made to "problem solving," and then he proceeds to give rather simple examples of how problem solving behaviors are analyzable in terms of his method. But Science and Human Behavior is a textbook for a sophomore college course, and it is in the volume Verbal Behavior, a major professional contribution, that he really tackles the problem of thinking in the most challenging sense in which the term is used. It is in connection with this truly challenging use of "think" that Skinner's statement applies: "Thought is simply behavior--verbal or non-verbal, covert or overt."

What is this most challenging sense in which "thinking" is used? Or said in another way, what are the characteristics of the S^D which set the occasion for the response "think" in this most interesting way?

The psychology of thought is especially interesting because people sometimes consider thinking to be the highest, most noble, function a human can manifest in his behavior. Thinking is truly a marvelous quality. It is something which stands for the uniqueness of the position of man among all other objects of nature. The capacity to think is the crowning achievement of creation. The capacity to think is sometimes viewed as an almost sacred possession; it is that quality shared by all human beings and possessed, if at all, only to a very limited extent by lower animals. Thinking, in short, is something very special. It is, in effect, the essence of the challenge of man to any science of behavior. Locked within the secret of thinking is the essence of man's humanity. This is the problem Skinner considers in his last chapter of Verbal Behavior.

What is Skinner's answer: "Thought is simply behavior--verbal or nonverbal, covert or overt." The marvelous, secret, special quality of man is not confined to some special mental process, to be identified by the term thinking. This special, fantastic thing is inherent in all behavior, whether one considers the behavior of man or the behavior of lower animal forms. The secret of man is the secret of life itself. What is thought? It is any and all behavior. Especially interesting, to be sure, is the fantastic, marvelous quality of human behavior. However, the behavior of humans obeys the same functional laws as does the behavior of any other living animal form.

Notice the beauty of Skinner's solution to the problem of behavior. When Skinner states that thought is behavior he does not suggest that humanity is without its secret. To the contrary, he proposes that the secret of man is inherent within the secret of nature. What is the nature of man? Do not ask that question. Let us consider only behavior. What can we observe to be the orderliness of human functioning?

But where, you may ask, does this treatment of the problem of thinking leave us, in view of the practical nature of our interest? We are faced, you may recall, with the practical problem of teaching people to think. Has Skinner nothing to say to help us in this regard?

Actually Skinner has a great deal to suggest by way of outline with respect to how specific aspects of the behaviors involved in specific instances of individual thinking are appropriately conceptualized in terms of his method of behavioral analysis. These points are made throughout the body of his work on verbal behavior. But one general implication is clear. The first step in analyzing "thinking" is clear. Someone must state exactly what behaviors are referred to under the heading of thinking. The assignment is clear. What must be done first in analyzing "thinking" is simply to describe those behaviors which we can agree constitute appropriate discriminative stimulation for the verbal response "thinking." But isn't this the first step in constructing any teaching-machine program? So let us turn now directly to that problem.

(The reader should be advised that at this point the instructional purposes of this paper end. What follows is an application of Skinnerian principles to the problem of programming thinking for instruction by teaching machine.)

APPENDIX B

THEORETICAL AND TECHNICAL NOTES

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THEORETICAL PAPER OF MARCH 1, 1961

(INTRODUCTORY NOTE: The following paper was originally presented to the students on the fourth meeting of the experimental class together with the material attached to this report as Appendix A. Audience variables controlling the composition of the paper included both the students in the class and the Project Director, who intended to use the work as a record of the rational activities associated with constructing the program. Consequently, even though two levels of difficulty are discriminable in the paper, it is more highly organized than the Technical Notes which follow in this Appendix.)

A. Introduction

Several comments by Skinner dealing specifically with teaching thinking by machine have appeared in print.

> The standard defense of "hard" material is that we want to teach more than subject matter. The student is to be challenged and taught to "think." The argument is sometimes little more than a rationalization, but it is doubtless true that lectures and texts are often inadequate and misleading by design. But to what end? What sort of "thinking" does the student learn in struggling through difficult material? It is true that those who learn under difficult conditions are better students. But are they better because they have surmounted difficulties, or do they surmount them because they are better? In the guise of teaching thinking we set difficult and confusing situations and claim credit for the students who deal with them successfully.
>
> The trouble with deliberately making education difficult in order to teaching thinking is (a) that we must remain content with the students thus selected, even though we know that they are only a small part of the potential supply of thinkers and (b) that we must continue to sacrifice the teaching of subject matter by renouncing effective but "easier" methods. A more sensible program is to analyze the behavior called "thinking" and produce it according to specifications. A program specifically concerned with such behavior could be composed of material already available in logic, mathematics, scientific method, and psychology. Much would doubtless be added in completing an effective program. The machine has already yielded important relevant by-products. Immediate feedback encourages a more careful reading of programmed material than is the case in studying a text, where the consequences of attention or inattention are so long deferred that they have little effect on reading skills. The behavior involved is observing or attending to detail--as in inspecting charts and models or listening closely to recorded speech--is efficiently shaped by the contingencies arranged by the machine. And when an immediate result is in the balance, a student will be more likely to learn how to marshal relevant material, to concentrate on specific features of a presentation, to reject irrelevant materials, to refuse the easy but wrong solution, and to tolerate indecision, all of which are involved in effective thinking.[1]

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[1] B. F. Skinner. "Teaching Machines," Science, Vol. 128, October 24, 1958.

The information presented in this quotation bears upon the purposes of this paper in two ways.

1. The basic nature of the task involved in programming a course in thinking is identified as one in which the first step is to describe and then analyze a set of specific behaviors which, upon the application of some criterion determined by convenience and functional utility, constitute in the generally educated verbal community discriminative stimuli for verbal responses involving the word "thinking." The remaining step is one of establishing these behaviors.

2. Skinner has listed at a high level of abstraction several classes of behaviors which are representative of the kinds of behaviors that typically act as discriminative stimuli for verbal responses containing the word "thinking" and which might well be programmed for a course in thinking to be taught by machine. The casual way in which these behaviors are listed is notable, for it suggests that Skinner is using as criterion in selecting these responses only some rather general interest on his part in making sense to the reader.

A second set of relevant remarks are made by Skinner in another paper.

> A similar device in which the sliders carry the letters of the alphabet has been designed to teach spelling. In addition to the advantages which can be gained from precise reinforcement and careful programming, the device will teach reading at the same time. It can also be used to establish the large and important repertoire of verbal relationships encountered in logic and science. In short, it can teach verbal thinking. As to content instruction, the device can be operated as a multiple-choice self-rater.
>
> Some objections to the use of such devices in the classroom can easily be foreseen. The cry will be raised that the child is being treated as a mere animal and that an essentially human intellectual achievement is being analyzed in unduly mechanistic terms. Mathematical behavior is usually regarded not as a repertoire of responses involving numbers and numerical operations, but as evidences of mathematical ability or the exercise of the power of reason. It is true that the techniques which are emerging from the experimental study of learning are not designed to "develop the mind" or to further some vague "understanding" of mathematical relationships. They are designed, on the contrary, to establish the very behaviors which are taken to be the evidences of such mental states or processes. This is only a special case of the general change which is under way in the interpretation of human affairs. An advancing science continues to offer more and more convincing alternatives to traditional formulations. The

> behavior in terms of which human thinking must eventually be defined is worth treating in its own right as the substantial goal of education.[2]

Specifically relevant in the above material to our purpose here is the statement, "They are designed...to establish the very behaviors which are taken to be the evidences of such mental states or processes." In other words, the function of the teaching machine program we are interested in constructing is to establish in strength those specific behaviors which act as S^D's for verbal reactions containing the term "thinking" under the particular set of circumstances with which we are concerned from a practical standpoint. The practical criterion to be employed in arbitrarily restricting the behaviors to be established by this program can be loosely identified at this point as "those ways in which we would like college students to manifest more effective thinking."

B. Purpose of Paper

The purpose of this paper is first to describe the initial activities of the experimental class whose assigned task it was to proceed as far as possible in constructing a program for teaching college students "effective thinking" by machine. It is also intended to present and describe at a fairly high level of abstraction the specific behaviors which have been selected to be programmed, and to set forth the intellectual considerations involved in making this selection. Also presented in this paper is a brief outline of the course to be programmed in overview, the purpose being to indicate roughly how much time will be devoted in the course to each major topic.

C. Initial Activities of the Experimental Class Preparatory to Selecting the Specific Behaviors to be Programmed

The experimental class was composed of eleven students and the writer as instructor. The educational and experiential background of the different members of the class was varied. One student was regularly enrolled as graduate student in the Department of Psychology, and he served in connection with the class as quarter-time research assistant under provisions of the grant. Three students were full time teachers working in the local high schools, two teaching English and one Basic Math and Diversified Occupations. Another student was a full time high school Counsellor. Two members of the class were employed in the administration of the county school district, one as Director of Instruction and Curriculum, the other as Elementary Coordinator. One student was Speech Therapist teaching currently at the junior high level, and another taught Science and Reading at a junior high school. Two students were full time graduate students at the University in departments other than Psychology, one in Education and one in Home Economics. The class met regularly on Wednesday evenings from 7 to 10 p.m.

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[2] B. F. Skinner. "The Science of Learning and the Art of Teaching." Harvard Educational Review, Vol. 24, No. 2, 1954.

At its first regular meeting following registration the class considered the types of problems likely to be encountered in trying to decide what is meant by "thinking," considered in the context of looking forward to constructing a teaching machine program dealing with that subject. Class discussion revealed that most of the members of the class tended roughly to differentiate between two types of thinking, "critical thinking" and "creative thinking." The class closed following a consideration of how each member of the class might explain what he felt to be involved in thinking by trying to specify the particular behaviors involved in the form of a list of specific acts which follow more or less in sequence. The assignment was made that each student bring to the next class meeting a list of the specific behaviors they considered to be involved both in critical and in creative thinking.

The second meeting was devoted to reading the lists of behaviors prepared by each of the class-members, and to discussing critically the behaviors described as they applied to the problem of programming thinking. There was considerable satisfaction among the members of the class at the remarkable unanimity of agreement in the class as to roughly what the major classes of behaviors were which constitute what they considered to be thinking in terms of the context developed within the class. The meeting closed with a decision that the instructor should prepare a written rationale to give specific direction to the next steps to be taken in programming. This rationale was to set forth the specific behaviors to be programmed, guided by the work the students had done, and organized within a practical framework determined by the fact that the programmed course is eventually to be offered at the University of Nevada for academic credit. What follows is a rationale intended to fulfill the students' assignment to the instructor.

D. Rationale for Selecting the Specific Behaviors to be Programmed

The specific behaviors offered by the experimental class as subject matter for programming were organized in terms of two kinds of thinking, critical and creative. The behaviors listed by the class in association with "critical thinking" can be conveniently described as problem solving, in much the same sense that Skinner employs the term in treating thinking as problem solving in Chapter XVI of *Science and Human Behavior*. The behaviors associated by the class with "creative thinking" were relatively similar in character to those listed under "critical thinking" but were more specifically oriented towards identifying the behaviors involved in making an original contribution in one or another of the fine arts, such as painting, prose composition, music, drama, sculpture, or poetry. The essential similarity of these behaviors reflects the current professional position that the basic psychological processes in the creative originality associated both with art and science are much the same.

However, the rationale to be advanced in this paper takes as its point of departure the position that neither critical nor creative thinking, vaguely defined by the specific behaviors submitted by the class, will be selected as the major subject matter to be developed by the program, but rather something else, another possibly-unnamed "kind of thinking" has been chosen to be established. The decision not to concentrate heavily upon either critical or creative thinking in this sense was made on the basis of primarily three considerations.

(1) First, the very specific behaviors one would want to establish in a program on critical or creative thinking vary rather extensively as a function of the particular field in which application of the behaviors is to be made. Although certain rather general habits could be established in the student which would be relevant to problem solving activity pretty much in any scholarly or artistic field, it seems inappropriate for the general college course on thinking to strengthen as much as one would need the more particular behaviors specialized in any one area of application. (2) Then, the technical problems faced in programming the appropriate behaviors for courses in critical or creative thinking in the various applied areas seem so relatively straightforward that the exciting challenge provided by an opportunity to do exploratory research in the area of thinking would seem largely to be missed in concentrating on these areas. The almost facile manner in which Skinner, as for example in the material quoted above, approaches the problem of teaching thinking suggests that little more than essentially technological drudgery is involved. It is already a matter of fact that many of the particular skills involved in critical and creative thinking are established in one way or another in many teaching machine programs. Such skills are clearly involved in programs which develop achievement in such intellectual areas as English Literature, Philosophy, or Psychology, or in such areas as Advanced Mathematics which undoubtedly call upon "logical reasoning." More particularly, programs have been or are being developed which specifically concentrate on the techniques of instructing problem-solving by machine, as in the research on training trouble-shooting techniques carried out by the Air Force Personnel Training Research Center,[3] or in Park's work[4] on managerial and

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[3] For example, see L. J. Briggs. "Problems in Simulation and Programming in the Design of Complex Trainers." In Lumsdaine, A. A. and Glaser, R. Teaching Machines and Programmed Learning. NEA, 1960.

[4] Gordon Park. "Electronic Keyboard Teaching Machines." In Lumsdaine and Glaser, Ibid.

administrative decision-making. The extension of the logic of these techniques to the area of creative thinking on the fine arts appears to this writer to have at this point the limited value of a technical tour de force. (3) And finally, and this is the real reason, the kind of behaviors that one is interested in for a college course in effective thinking are slightly different in nature than the majority of behaviors that need to be established in teaching problem-solving and creative thinking as they pertain to particular areas of application.

The much more challenging set of behaviors which have been selected for programming in this research might perhaps be roughly indicated by the phrase "active intellectual consideration," or to use Piaget's phrase "reflective intelligence"; however, there is little purpose to be gained by trying to subsume the particular behaviors we have selected under some commonly-employed heading. The specific behaviors chosen were selected frankly because they seemed to be basically what a number of college instructors want their students to do when these same instructors try to encourage their students to think. The prospect of attempting to program these particular selected behaviors strikes the writer as relatively challenging indeed, and as material profitably and appropriately to be included in a college course on "How to Think." (Whether or not these specific behaviors serve as legitimate S^D's for the response "thinking" on the part of the reader of this paper is, of course, determined by his previous reinforcement history.)

Certain more or less intellectual considerations, however, have also played a part in determining the particular behaviors selected for programming. These intellectual considerations will now be briefly set forth.

It is appropriate, first, to consider the "need" for a college course in thinking. In asking questions concerning the nature of any "need" for such a course in a given academic community, one looks in attempting to answer the question simply and directly at the variety of discriminative stimuli which set the occasion for whatever verbal behavior exists with respect to the "thinking" of college students, the important verbal behavior in this regard being largely restricted, for purposes of our observation here, to that of the instructional staff. In other words, the "need" for a course in thinking is defined by the particular behaviors in which students engage that lead to comments, public or private, by instructors concerning the character of the "thinking" of their students. Certain implications of the term need in this connection are apparent. Insofar as we are interested in the "need" for a course in thinking, the relevant discriminative stimuli are predominantly aversive in nature. That is, the "need" arises for special instruction in thinking because the students engage in particular behaviors which instructors do not like.

It is not difficult to identify the particular kind of aversive student-behaviors which lead instructors to wish for more "thinking" on their part. Typical of such student behaviors are the following. (1) Students appear not to be interested or attentive when especially challenging or difficult material is being presented in lecture. (2) Students seem unable to emit appropriate verbal responses to questions when called upon in class, especially under the circumstance where no new specialized information is required for an answer. (3) Students seem at times simply to accept at face value material presented in lecture which the instructor knows is controversial. (4) Students fail to ask questions of the instructor when his presentation has been to him embarrassingly inaccurate or otherwise defective. (5) Students make statements in class which clearly reflect social biasses or bear little relation to available information and evidence. (6) Students seem at times to be unaware of the limitations of the information and evidence they hold, and seem not to be interested in acquiring new evidence. (7) Students simply behave in an "unsophisticated" or "uneducated" way, and make statements which simply reflect values different from those of the instructor. And so on. It is clear that much of the verbal behavior which defines the "need" for a course in thinking has as its discriminative stimulation aversive behaviors of the sort described above.

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As predominant as such aversive stimulation may be in defining thinking in this sense, it need not be so for there are other ways in which conversation related to student thinking may be related to positive reinforcement. (1) A student may make a remark in class that the instructor has not heard before. (2) Students may have on their faces expressions of troubled, but silent, disagreement. (3) Students may challenge frequently what the instructor is saying in a way that he finds stimulating. (4) A student may support his statements with a range of relevant evidence. (5) A student may use deductive method in making a point in class. And so on.

These various behaviors which serve to set the occasion for comments on student thinking have been mentioned here because they illustrate the fact that, even though the "need" for a course in thinking for college students exists ultimately in the form of discriminative stimulation for certain verbal behavior, the task of programming a course in thinking does not become one of simply exerting some measure of control over the frequency with which these S^D's occur per se. This is the case because it is possible to establish in the students overtly observable behavior patterns which will serve effectively to stimulate more favorable verbal reactions from their instructors yet which will not reflect the non-observable behaviors which are generally taken to be involved in thinking. That is to say that even though the real "need" for a course in thinking ultimately takes the form of student reactions that are overtly observable to instructors, it would be trivial simply to try to establish desirable overt behavior patterns in the students. It is one thing to get a student to look with steady gaze at the instructor; it is another thing to get him to attend to the instructor "because he is interested." Point: the problem of programming a course in thinking is presented to us as a consequence of student behavior patterns which are fundamentally publicly observable; but the task faced in actually programming the course is to establish behaviors which are only incidentally publicly observable. In other words the behaviors to be established by this program are predominantly covert. It is in the emphasis on selecting explicitly covert behaviors to be programmed that the challenge of this particular study lies.

What, then, are the specific covert behaviors to be established? The answer to this question, of course, depends upon what covert behaviors are desired of the student. The selected behaviors reflect the values of the writer. The specific covert behaviors to be established by the program, identified at a high level of abstraction, are as follows.

MAJOR STEP ONE. Increase the discriminative control that spoken and written verbal behavior has over the student's self-reinforced textual and covert intraverbal behavior. (Increase the frequency with which students spontaneously pay attention to the texts they read and lectures they listen to.)

MAJOR STEP TWO. Increase the frequency of the student's self-probes related to identifying the major sources of discriminative control over the speaker's behavior for both spoken and written material. (Increase the frequency with which the student consciously tries to understand the point of what he is reading or listening to.)

MAJOR STEP THREE. Establish differential response patterns to three degrees of similarity between the verbal behavior of the speaker and that of the student as listener. (Teach the student to react differently to what he is reading or listening to depending on how familiar he is with the material.)

(A) For low levels of similarity between the verbal behavior of speaker and listener (when the student is very unfamiliar with the material)

1. establish the behavior of first estimating the practical value of strengthening this verbal behavior in himself (get the student to judge whether or not it is important for him to try to understand the material).

2. strengthen the behavior of avoiding the verbal material if it is judged to be of little personal value.

3. strengthen self-mands related to increased concentration and other habits related to persistence if the material is judged to be of personal value.

(B) For intermediate levels of similarity between the verbal behavior of speaker and listener (when the student feels he understands the point but disagrees with the material).

1. establish the behavior of first testing explicitly the dissimilarity between the verbal behavior of speaker and listener either by overt question or covert review (get the student first to check whether or not he has correctly understood the speaker).

2. strengthen the behavior of then probing himself or speaker in an effort to identify the sources of strength of the speaker's behavior. (Then get the student to try to figure out what made the speaker or writer say what he did.)

(C) The differential reaction to a situation involving high similarity between the verbal behavior of speaker and listener is socially immaterial. (In this case the student either agrees with the speaker or has just understood a new idea.)

A substantial portion of the program will be devoted to establishing and strengthening the behaviors summarily indicated above in view of the clearly adaptive nature of the behaviors involved. Such behaviors are adaptive in the sense that they function essentially simply to increase the degree to which he "understands" or behaves in consonance with his verbal social environment.

However, a smaller portion of the program will be devoted to developing a different set of skills of a patently more "critical" nature. In addition to valuing the "positive" and "trusting" behaviors listed above, society also reinforces more "negative" or "doubting" responses to certain verbal material, a practice reflected in the value placed upon "critical" thinking. It is instructive to reflect upon the sources of the social reinforcement of critical, or intellectually evaluative skills. To a certain extent critical, skeptical behavior is undoubtedly maintained because it is positively reinforcing to the verbal community, as in situations where a heated verbal interchange leads to some modification in verbal behavior valued by one or more of the parties concerned. However, it is the opinion of the writer that the major part of the social reinforcement which maintains critical and evaluative behavior is negative in nature, in the sense that it reduces the threat inherent within certain types of verbal behavior. The major discriminative stimuli which set the occasion for critical behavior negatively reinforced by society seem to fall into one or two categories: verbal behavior which tends to be identified as "original" on the one hand or "unethical" on the other. Since both "original" and "unethical" behavior tend to constitute a threat to society, the aggression and hence aversive stimulation of critical and evaluative behavior tends to serve the purposes of social control. Since the writer holds considerable question in mind concerning the personal and social value of skeptical attitudes in general, and since genuinely moral issues are raised in attempting to decide which among a number of alternative social behaviors involved in critical and evaluative skills should be established, a smaller amount of time in the program will be devoted to these behaviors, and less of an effort will be made genuinely to establish and strengthen them. Instead, the material will be presented at an "intellectual" level more or less as subject-matter to be retained in memory. Hopefully, if the program has any effect upon the critical behavior of the student, it will take the form of self-mands in which the individual rather consciously "knows" what is recommended by the program and then "decides" whether he is going to "use" the information or not. This is perhaps the point at which the writer should register his personal shock at finding himself, in attempting to construct a teaching machine program, in a position where he may well be determining on the basis of his own values the choices other people will make in regard to their social attitudes and actions.

At any rate, approximately the following intellectual attitudes will be strengthened in the program.

1. The student should learn to discriminate between that verbal behavior which is "original" or "unethical" in the sense that it may be socially threatening and that which is sufficiently conformist to be safe.

2. Then the student should react to the discriminative stimuli associated with socially threatening verbal behavior in the following ways.

a) First formulate an efficient statement of the threatening idea.

b) Then construct efficient statements of other pertinent ideas for which you feel there is significant support.

c) Review the evidence which bears upon the issue.

d) Check out the central evidence and determine the sources of strength for its report.

e) Review the positions taken by various authorities, including yourself, taking their trustworthiness into consideration.

f) Act upon your hunch (verbally, socially, emotionally, or whatever).

A similar section of the program will be devoted to presenting the content of general method in the creative processes. The approximate length of time to be devoted to each of the major sections of the program is indicated in the following Course Outline.

I. Introduction to the nature of thinking (standard treatment) and of the social value of effective thought. 1 week

II. Establish and strengthen the specific behaviors outlined above. 10 wks.

III. Present content on critical and evaluative behavior. 3 weeks

IV. Present content on general creative method. 2 weeks

(COMMENT: It should be stated that the Project Director has considerable doubt in his own mind about the legitimacy of dimensionalizing "degree of similarity between the verbal behavior of speaker and listener," especially insofar as interpretation of the dimension is made both in terms of degree of understanding and extent of agreement. Moreover, in spite of the fact that the Project Director feels he can spell out in considerably more detail the line of reasoning he followed in arriving at the seven steps in "critical evaluation" listed above, the results of his reasoning in this regard sound so unusual to him that they are presented here with some hesitation.)

TECHNICAL ANALYSIS OF MARCH 8, 1961

(INTRODUCTORY NOTE: This paper is essentially a more detailed consideration of the technical problems faced in the major section of the program--that section designed to establish the specific behaviors identified as "thinking" itself. This major section of the program was differentiated in the paper of March 1 from three other sections identified under the headings Introduction, Critical Evaluation, and Creative Method. The restriction of this analysis to the central section of the program reflects the decision made that the experimental class should move at once to programming "thinking" as such and postpone until the completion of this section work on the others. Since it had been decided to approach the content of the remaining three sections only at an intraverbal level, they are programmed from a technical standpoint much as any other academic subject matter.)

MAJOR STEP ONE

Gross statement of objective: Increase the discriminative control that spoken and written verbal behavior has over the students' self-reinforced covert intraverbal and textual behavior. (Increase the frequency with which students spontaneously pay attention to the lectures they listen to and the texts they read.)

How can we bring increased self-reinforcement to bear on academic listening and reading?

1. Carefully prepared lectures and texts can be constructed so that they provide self-reinforcement insofar as they stay just a step ahead of the student (thus providing the high reinforcement of the speaker's saying what it is that the listener is about to say). By programming lectures and texts in this way the specific lecturer and text gain increased discriminative control over textual and intraverbal behavior of listener (these become "good" lectures and texts). One could expect a certain amount of generalization to increase the discriminative control of other lecturers and texts.

2. Self-reinforcement could be increased by extending the range or breadth of the listener's verbal repertoire, thus increasing the similarity of the verbal behavior of speaker and listener. This is reflected in the observation that education has a cumulative effect: the more one really learns the more he is interested in continuing his learning. If such a broadening of the verbal repertoire is accomplished with many different speakers and texts, it would be expected

that teachers and books would acquire a high degree of generalized discriminative control over the listener's behavior.

3. If spoken or written material becomes an occasion for externally applied reinforcement, lectures and texts would be expected to gain in discriminative control through generalization.

4. Self-reinforcement is ultimately achieved when lectures and texts set the occasion for covert behavior on the part of the listener which is then reinforced either externally or by the listener himself. Frequently considered to be effective in this regard is covert behavior on the part of the listener which takes the form of asking questions about the spoken or written material. (The first step in the Q3R technique for developing effective "study habits" is to encourage the student to ask questions concerning the material.)

A problem arises in reinforcing listening or reading behavior: in reinforcing listening or reading behavior where specific lecture or written material is used, the particular characteristics of the material attended to come to acquire the maximally effective discriminative control. This discriminative control can be counted on to generalize to other written and spoken material, the amount of generalization being a direct function of the similarity of the new and the original material. However, as the listener encounters spoken and written material that is not a part of the program and reinforcement is not forthcoming, extinction takes place with regard to this generalized stimulus control, and the specific characteristics of the originally programmed material assume, relatively, an even tighter control. Since we are interested in a highly generalized discriminative control of spoken and written material over the listener's behavior, the program should vary as much as possible in the specific character of the material consistently reinforced, and great care should be taken to insure that the material presented by program is typical of the range of verbal behaviors we wish to acquire discriminative control (this means the program should include "poor" lecture material and "dull" texts). Moreover the effort should be made to incorporate within the program some means of control over the daily academic reactions which the student is involved with outside this particular course. It should be kept in mind that we are particularly interested in strengthening the discriminative control exercised by verbal material that the student finds difficult. Thus in the program much material should be given which will strike the student as "difficult" to begin with so that the reinforcing effect can apply largely to those academic situations which the student is not likely to find reinforcing to begin with.

MAJOR STEP TWO

Gross statement of objective: Increase the discriminative control over the student's behavior of the variables which control the gross organization of the speaker's composition. (Increase the frequency with which the student comprehends the major points being developed in what he is reading or listening to.)

What is it to "comprehend" what is read or heard? People understand verbal material when they tend to emit the same responses as the speaker in the same discriminative situation. In the present case, however, we are interested when we speak of "comprehension" in whether or not the student can see what it is that the speaker is driving at, or whether or not the student responds verbally to those gross discriminative situations which set the occasion for the particular composition the speaker emits, to those gross discriminative events about which the speaker is basically talking. The problem faced by the programmer is here also one of discrimination training. Verbal behavior must be reinforced in the presence of the same discriminative stimuli which set the occasion for the speaker's behavior. The technical difficulty is to make these S^D available to the student, since they appear largely as verbal events and they may or may not be stated in a form which exercises much control over the student's response. In spoken or written material which has been especially composed to present discriminative stimuli which are fairly certain to set the occasion for responses appropriate in this way, the only problem which stands in the way of appropriate control is the "attention" of the student. This aspect of the problem is presumably under the influence of the programming in Major Step One. However, most of the time these discriminative stimuli are not explicitly present, "explicit" in the sense that they exert control only for the relatively highly trained person. Thus the major problem of this step is one of "calling attention" to those aspects of the material which provide the appropriate S^D. This can be done by making use of increasingly complex identification responses in which the student is asked to respond to the variety of levels of organization contained within the material. However, the strengthening of "comprehension" itself is achieved only by reinforcing appropriate verbal response in the presence of the material. This can be achieved by asking the student to emit verbal responses to the material, once he has "learned how to pay attention to" the relevant S^D.

MAJOR STEP THREE

Gross statement of objective: Establish differential response patterns to three degrees of similarity between the verbal behavior of the speaker and that of the student as listener.

The remainder of the program has basically the dimensions of complex response differentiation training. The responses to be strengthened already exist in high strength in the repertoire of most students, and the S^D's under whose control the responses are to be placed already set the occasion for a variety of differential reactions. A fairly simple discrimination training must be carried out preliminary to strengthening the differentiated responses which comprise the essence of this major part of the program. In this preliminary training, a discrimination must be established between three levels of similarity in the behavior of speaker and listener. The relation between the three levels of similarity and the verbal identification to be strengthened will be accepted at that level already existing in the repertoire of the student. These relations will be strengthened simply by following them with reinforcement. The reinforcement to be applied can be conveniently the self-reinforcement associated with simply being able to answer a question and the reinforcement associated with being presented a new question. Actually the main thing to be accomplished in this preliminary training is the behavior of classifying the level of "difficulty" of the material with which the student is confronted.

Step Three (A)

To an S^D of low similarity, establish as response the covert behavior of probing self with respect to the personal value of strengthening the material in the repertoire. This can be accomplished by setting the occasion for such self probes in the form of a direct question "What is the value of this material?" The response follows due to the previous reinforcement of mands in the history of the student. Since the response is emitted in the presence of low level similarity and is followed by inherent self-reinforcement or that associated with an interesting or easy question, the relation we are interested in becomes strengthened. At the same time, the behavior of self-probing for the value of things becomes strengthened by generalization. Essentially similar processes are involved in the second part of Step Three (A); however the generalization strengthens the behavior of decision making rather than that of probing for personal value. This decision making behavior is strengthened as is the associated self-probe by the reinforcement implied by the program's respect of the student's "no" (a completely new problem is presented), and by the self-reinforcement implied when the student successfully answers an easy question about the difficult material in such a way that his verbal repertoire is strengthened (the reinforcing question deals with new or technical vocabulary, for example.)

Step Three (B)

The contingency established to the intermediate level of similarity between the behavior of speaker and listener involves the straightforward covert response of the self-mand: "Check to be sure you have understood the material." This response can in effect be elicited as a textual response to the instruction presented by machine, and the behavior can be expected to follow with a certain strength due to the social reinforcement which usually maintains appropriate response to mands. A certain amount of self-reinforcement should be expected to strengthen this behavior; however, this reinforcing effect can be heightened by employing as the next frame a question which can be answered only if the passage has been understood to an effective extent. Whenever the student responds to the mand with an appropriate check, and reinforcement follows, this checking-behavior will be strengthened. On the other hand, if the student does not check the material in response to the mand, and reinforcement follows, the undesired behavior of not-checking will be strengthened. If the failure to check is followed by inability to answer the subsequent question, the aversive stimulation provided should lead the student then to check in response to the next mand; however, other undesirable methods of reducing the aversive stimulation may be adopted, such as emotional response or "loosing interest." Therefore in the design of the subsequent question, the question should be centrally germane but easy enough to insure high probability of correct response. These questions should be very carefully constructed so that they are easy to answer after a review but difficult without an appropriate review. The level of difficulty of these questions should increase gradually after the manner of response differentiation.

It is further to be expected that the nature of the question asked following the instruction to check would exert considerable control over the nature of the responses involved in the self-probe. This effect is expected due to the differential response shaping observed in response differentiation. Gradually three increasingly complex, increasingly appropriate behaviors could be established: 1) simple review, 2) verbalization of difficulty, and 3) judgment of adequacy of speaker's behavior.

Step Three (C)

In situations of high similarity between behavior of speaker and listener the differential response to be established is not of great practical importance, yet it is considered desirable simply to increase to some extent the frequency of emission of verbal behavior concerned with estimating how to obtain more information if desired. This relation can be strengthened simply by requesting the individual to make such a considered estimation and simply giving appropriate information as reinforcement. The mere presentation of such information would be expected to increase the relevant verbal repertoire to a certain extent and to increase the control that similar material has over the response: "I can learn more about it by ...."

As a general rule, in situations where covert behavior is manipulated and students' "choice" or "evaluation" is determined, undesired responses are to be followed by presentation of a completely new problem, desired responses by pertinent questions which can be easily answered. Obviously the program involves branching.

(COMMENT: It is to be noted that certain changes in the organization of the program are made above from the position taken in the paper of March 1. The gross statement of objective for Major Step Two has been altered, omitting the self-probe. Minor changes are also indicated for the second part of Step Three (B) and Step Three (C).)

OUTLINE OF PROGRAMMING PROCEDURE

March 15, 1961

(INTRODUCTORY NOTE: The following material was distributed to the class as a guide for their initial specific activities in programming.)

Steps to be taken

1. Select a broad range of academic subject matter to be employed; e.g., Anthropology, Biology, Music, Philosophy, English Literature, Home Economics, Education, Psychology, P. E., Physics, Chemistry, Mathematics, History, Art History.

2. Collect bibliography of reading material, one to two paragraphs in length, in each of the above areas.

3. Classify selected bibliography as to level of difficulty (degree of similarity to verbal repertoire in strength on part of student) in six classes: extremely similar (very interesting and understandable), very similar, similar, moderately similar, relatively dissimilar, highly dissimilar.

4. Classify material in terms of "quality of writing" in three groups: very carefully composed, average composition, poor and confusing composition.

5. Compose a number of questions for each bibliographical selection for each of the following categories of question:
   - A. "Attention"
     - (a) simple word identification
     - (b) technical word identification
     - (c) identification of explicit definition
     - (d) identification of implicit definition
     - (e) identification of statement of fact
     - (f) identification of statements of interpretation
     - (g) identification of statement of opinion
     - (h) identification of point of argument
     - (i) identification of omission of evidence
     - (j) identification of conclusion not following from evidence
   - B. "Comprehension"
     - (a) word emission related to fact
     - (b) word emission related to technical word
     - (c) phrase emission related to topic
     - (d) phrase emission related to point

6. As you move into Major Step Three construct questions asking student to classify material into one of three classes: (1) very difficult to make much of any sense out of; (2) material which he either knew beforehand or finds very interesting; (3) anything else.

7. Construct follow up question for answer 6-(1): (a) ask student to emit statement identifying what value it would be for him to be able to make sense out of material; (b) ask student to decide yes or no whether it is worth two minutes to learn one thing about the material; (c) ask identification question of technical term defined if he has answered "yes"; present completely new material if he says "no."

8. Construct follow-up question for answer 6-(2): ask student to emit answer to question on how he can learn more about topics. Reinforce with relevant information.

9. Construct follow-up question for answer 6-(3): Set up mand: "Check your understanding.

10. Construct follow-up for step 9 above.

(a) Ask student to identify most confusing sentence. Reinforce by giving one sentence that is likely to be confusing: "Most people would find____________ sentence confusing."

(b) Ask student to verbalize difficulty with passage. Reinforce with hypothetical difficulty.

(c) Ask student to verbalize his judgment of whether speaker has made his point, more or less. If so, present new situation. If not, ask student to verbalize inadequacies of speaker's material. Reinforce with easy relevent question, or by considered criticism.

11. As the above behaviors become strengthened for written material (at first it will be presented solely by machine, then college texts and other printed material will be used), the extension to spoken behavior will be made, possibly first by presenting material on tape, then by getting students randomly to sample classes for 10 minutes, performing essentially the procedures indicated in 10 above. Finally, as the course nears completion both verbal and written material in their own classes will be used.

12. Material at the very first will be easy and interesting, in order to establish the behavior of using the machine. Then, a random assortment of material in the different categories will be presented. The behavior of attending and comprehending will be maintained by machine throughout the course.

(COMMENT: It was in their effort to follow the above outline that the experimental class proved to be of considerable value in determining the ultimate structure of the program. After assembling sufficient subject-matter bibliography, the class moved directly to Major Step One, programming "Attention." After some 200 "Attention Questions" had been composed, the class prepared a comparable set of "Comprehension Questions," attempting to follow the above outline. It became finally apparent that the instructions given in the above outline for constructing "Attention" and "Comprehension" questions were grossly inappropriate. The nature of the error here is instructive. The difficulty did not lie in the theoretical formulations of March 1 and March 8. Instead, the kind of questions indicated in the above outline failed upon more critical evaluation to bear genuinely upon the behavioral characteristics specified by the theoretical analysis. It became apparent that what the class submitted as "Comprehension Questions" fulfilled much more the theoretical requirements for Major Step One and that no material really pertinent to Major Step Two had been obtained. Pressures related to limited time led then to the decision to move on to the more challenging problems of Major Step Three, identified for the class as "Thinking Proper.")

OUTLINE OF MAJOR STEP THREE-B, "THINKING PROPER"

April 26, 1961

(INTRODUCTORY NOTE and COMMENT: The fact that the experimental class had devoted so much time to the construction of "Attention" and "Comprehension" questions which, after the fact, could be seen to bear on their theoretical interests in a fashion other than had been anticipated led to a decision to review a number of different ways of constructing questions, concentrating after various types of questions had been devised on the extent to which the different types appeared to strengthen behaviors relevant to Major Step Three. This change in orientation was instructive, since it revealed we had too glibly assumed that particular types of questions could be expected to strengthen the specific behaviors in which we are interested. As a result of this increased concentration on the nature of the question to be used we found ourselves in a position where we had identified a type of question which seemed to bear clearly upon behavior we were interested in shaping and where we had a clearer conception, really, of the class of behaviors we wanted to strengthen as "thinking." This led to a modification of the behaviors listed under Major Step Three-B in the papers of March 1 and March 8. Instead of strengthening in the student behaviors of checking his understanding of the speaker and then trying to figure out why the speaker was attempting to make his particular point, it seemed quite a bit more sensible to attempt to strengthen the frequency with which the student initiated questions on his own which bear rather directly on the implications of the speaker's verbal behavior. At the same time, we felt in a position to be able to define rather explicitly the difference between an "Attention Question" and a "Thinking Question," the latter requiring for its answer information not available from the behavior of the speaker but obtainable only from a proble of the listener's own repertoire. Moreover, our experience in writing "Attention" and "Comprehension" questions and the results of our trying these questions out on an experimental student had led us to doubt that our interest in establishing different behaviors to different degrees of similarity between the verbal behavior of speaker and listener was realistic. Bibliographical material which the class would judge to be grossly different in level of difficulty seemed to have an obscure and possibly unimportant effect upon the behavior of our experimental student. Therefore, it was decided to delay until we had had more experience in building the program further consideration of Steps Three-A and Three-C. The following outline of the structure of the program for Step Three-B was accordingly prepared and submitted to the class, who then set to work preparing material in the form indicated. It should be noted that this section of the program involves strengthening behavior in four stages; by the end of the semester the class had completed enough questions for slightly more than one set pertaining to the first of these four stages.)

STAGE A:

Card 1. Present subject-matter paragraph to student.
Card 2. Present Attention Question on subject-matter.
Card 3. Present correct answer to Attention Question.
Card 4. Present Thinking Question
Card 5. Present a reasonable answer to the Thinking Question.

STAGE B:

Card 1. Present subject-matter paragraph to student.
Card 2. Present Attention Question on subject-matter.
Card 3. Present correct answer to Attention Question.
Card 4. Present instruction, "Write down a question related to the preceding material that is not answered in the paragraph."
Card 5. Present an example of a good Thinking Question.

STAGE C:

Card 1. Present subject-matter paragraph to student.
Card 2. Present Attention Question on subject-matter.
Card 3. Present correct answer to Attention Question.
Card 4. Present instruction, "Write down an example of a good thought question."
Card 5. Present an example of a good Thinking Question.
Card 6. Present instruction, "Answer question on Card 5."
Card 7. Present a reasonable answer to the Thinking Question.

STAGE D:

Card 1. Present subject-matter paragraph to student.
Card 2. Present Attention Question on subject-matter.
Card 3. Present correct answer to Attention Question.
Card 4. Present instruction, "Write down an example of a good though question."
Card 5. Present an example of a good Thinking Question.
Card 6. Present instruction, "Answer your own thought question."
Card 7. Present instruction, "Write down any criticism you have of the answer you gave to your thought question."

SAMPLE SET OF "ATTENTION QUESTIONS"

(INTRODUCTORY NOTE: This is the second of four sets of "attention questions" prepared by the Project Director. It has been checked out on one experimental student, a female college sophomore of average academic achievement, who completed the set without error in approximately 35 minutes.)

S-1 One of the foremost questions on the agenda today concerns the role Germany will play in world relations. A decade after its bold bid for world domination ended in disaster and the nation seemed shattered forever, Germany again looms large indeed on the international scene.

R-1 A decade after its bold bid for world domination ended in disaster, ______ again looms large indeed on the international scene.

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S-2 The soil scientist restricts the word "soil" to the surface material, which over a long period of years, has come to have distinctive layers, or horizons. It has certain distinctive physical, chemical, and biological qualities which permit it to support plant growth and which set it off from the infertile subsoil or bedrock lying beneath. The true soil is composed both of mineral and organic particles, whereas the underlying material may be, and usually is, wholly mineral in matter.

R-2 The true__________is composed both of mineral and organic particles, whereas the underlying material may be, and usually is, wholly mineral matter.

- - - - -

S-3 Over the slender bridge of the genes one generation is connected to the next, and the yesterdays reach into the present, and the present into tomorrow, as long as life shall endure. The minuteness of the hereditary link between one generation and the next is such as to challenge the imagination. It is difficult to comprehend that the genetic link between the present generation of man and the next represents a total mass equivalent to just one and a half drops! This is the volume of the nuclear material involved in the production of two billion human beings.

R-3 It is difficult to comprehend that the genetic link between the present generation of man and the next represents a total mass equivalent of just one and a half __________! This is the volume of the nuclear material involved in the production of two billion human beings.

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S-4 The elementary principal should know the issues and be ready and anxious to discuss them with the public without excitement and defensiveness; he ought to be able to discuss with parents and other citizens the weaknesses and needs for improvement and change, without trepidation or resentment. Parents and community can join constructively with school in dealing with issues and in bringing about needed and desired change, in an atmosphere of friendliness, cooperation, and trust.

R-4 The elementary-school____________ought to be able to discuss with parents and other citizens the weaknesses and needs for improvement and change within his own school.

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S-5 The party of Eskimo men and women brought back by Lt. Peary from his Arctic expedition in 1879 were unable to endure our temperate climate. Many died of pneumonia and the survivors were so enfeebled that all had to be restored to their icy homes to save their lives.

R-5 Many Eskimos died of_______________.

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S-6 The application of heat to an object usually causes an increase in its temperature. The term temperature is used to express how cold or how hot an object is; cold implies a low temperature and hot a high temperature.

R-6 The term____________is used to express how cold or hot an object is.

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S-7 A more definite idea of temperature can be realized by considering what occurs when a hot body is brought in contact with a cold one; for example, a hot steel forging plunged into cold oil. The forging becomes cooler and the oil warmer, the hot body giving up some of its energy to the cold one. This process continues until a state of thermal equilibrium is reached, in which the same temperature prevails throughout. A statement of the temperature of an object signifies that its molecules possess a particular amount of energy due to thermal agitation, an increase of temperature signifying a corresponding increase in molecular energy.

R-7 An increase of temperature signifies a corresponding increase in molecular _______________.

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S-8 You have learned that atomic energy is locked up in the atoms of certain elements. When atomic energy is released, one kind of atom is changed or changes into some other kind or kinds. Most of the sun's energy seems to be produced when hydrogen changes into helium. By several steps, four hydrogen atoms combine to form one helium atom. But a helium atom weighs slightly less than four hydrogen atoms. So a small amount of matter is lost during the change. In other words a tiny bit of matter disappears. At the same time a considerable amount of energy appears. The matter has changed into energy.

R-8 In other words, a tiny bit of matter disappears. The matter has changed into_____________.

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S-9 From "Paradise Lost" by Milton
"Farewell, happy fields, where joy forever dwells! Hail, horrors! Hail, Infernal World! And thou, profoundest Hell, Receive thy new possessor -- one who brings a mind not to be changed by place or time. The mind is its own place, and in itself can make a Heaven of Hell, a Hell of Heaven."

R-9 "And thou, profoundest Hell, Receive thy new possessor -- one who brings a _________not to be changed by place or time. The mind is its own place, and in itself can make a Heaven of Hell, a Hell of Heaven."

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S-10 On the average, the proportion of Americans who vote is smaller than that of the British, French, Italians -- or Russians. Talk as we will about the right to vote, the hard fact remains that millions of Americans do not want to vote or somehow fail to get to the polls on election day. The startling feature on nonvoting in America is its extent. In recent residential elections only about three-fifths of the potential voters showed up at the polls.

R-10 On the average, the proportion of Americans who ______ is smaller than that of the British, French, Italians -- or Russians.

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S-11 Man is very much of one kind with higher animals, the Anthropoid Apes above all. He has so much in common with them that in any unprejudiced view he must without hesitation be classed with these creatures. In other words, Anthropoid Apes, each one in its own way, represented specializations in development which are on the direct route to man.

R-11 In other words, the ____________ Apes, each one in its own way represented specializations in development which are on the direct route to man.

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S-12 When silver-nitrate solution is brought into a strong light chemical change takes place. You can tell this because the solution turns dark. A similar change takes place when you take a picture with a camera. The film has a chemical on it that is easily changed by light. When you open the shutter of the camera for an instant, light strikes the film and starts a chemical change in it. This change is completed when the film is developed. If light gets into the camera before you are ready to take the picture, the chemical change takes place before you want it. Then the film is spoiled.

R-12 The film has a chemical on it which is easily changed by ____________.

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S-13 So far as history and legend record, Ireland boasts by far the most ancient organized sports, the Tailteann games. The Tailteann games, or Lugnasad, were traditionally established about 3000 years ago by Lugaid of the long arm, one of the early Irish gods, in honor of his foster moster, Taliti. Cuchulain, the mythical Irish hero, is said to have taken part. For many centuries these games and others like them were kept up in Ireland; however, the almost constant wars which harried the country finally destroyed their organization. The Irish were for many centuries an important factor in British athletics, as well as in the U.S. and the British dominions overseas. The Tailteann games were successfully revived at Dublin in 1924, following the VIII Olympic games held at Paris in the same year.

R-13 The Tailteann games were successfully revived at Dublin in 1924, following the VIII ____________ games held at Paris in the same year.

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S-14 In how many different ways may the letters a, b, c be arranged in order on a line? By trial we discover that there are exactly six arrangements without repetitions: abc acb bac cab cba bca

R-14 In how many different ways may the letters a, b, c be arranged in order on a line? By trial we discover that there are exactly ______ arrangements without repetitions.

S-15 In how many different ways may the letters a, b, c be arranged in order on a line? By trial we discover that there are exactly six arrangements without repetitions:

abc acb bac bca cab cba

Each arrangement is called a permutation, and we say that there are six possible permutations of three letters.

R-15 We say that there are six possible ____________of three letters.

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S-16 In how many different ways may the letters a, b, c be arranged in order on a line? By trial we discover that there are exactly six arrangements without repetitions:

abc acb bca cab cba bac

Each arrangement is called a permutation, and we say that there are six possible permutations of three letters. If there were a large number of letters, say the 26 letters of the alphabet, it would be tedious indeed to list all possibilities. In fact the number of permutations of 26 letters turns out to be so large that it would take many years to write out a list. What we need is a general principle which will give the number of permutations of "n" objects without requiring the labor of listing.

R-16 What we need is a general principle which will give the ____________of permutations of "n" objects without requiring the labor of listing.

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S-17 Lord Chesterfield has the following remarks on self-instruction in grammar: "It is of great importance for every one to speak and write their own language correctly and elegantly. In order to do this, young people should get an habitual but unaffected purity, correctness, and elegance of style in their common conversation; they should seek for the best words, and take care to reject improper, inexpressive, and vulgar ones. They should read the greatest masters of oratory, both ancient and modern, and observe their choice of words, their harmony of diction, and their method; they should never cease improving and refining their style upon the best models, till at last they become models of eloquence themselves, which by care it is in every man's power to be."

R-17 In order to do this, young people should get an habitual but unaffected purity, correctness, and elegance of ________in their common conversation.

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S-18 The word loyalty has been poorly defined and badly abused. Loyalty has been thought of as a devotion of staff to leader -- as loyalty up. Some administrators have even defined it as a type of subservience on the part of the staff -- a sort of blind faith in the leader. These concepts seem shallow and unwise in a democratic system. The alert leader realizes that one has to give to receive loyalty; that loyalty down is as important as loyalty up. The real leader is loyal to a deserving staff and in turn, receives loyalty from them.

R-18 The alert leader realizes that one has to give to receive loyalty; that loyalty _________is as important as loyalty up.

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S-19 A study of the development of civilization indicates that society has its roots in the soil. Records of man's early development show that his progress was considerably accelerated when he began to grow crops, and as he changed from the precarious life of the primitive hunter and nomad to the more secure sedentary life of the tiller of the soil. Nomadic kingdoms of the past lacked stability; they were not permanently rooted in the soil. Nomadic people contributed comparatively little to existing culture until they ceased to be nomadic and became tillers of the soil.

The growth of Egyptian and Babylonian civilizations appears to have been closely associated with the successful development of agriculture in areas of alluvial soil materials. The civilization of monsoon lands is often called a "vegetable civilization." It is basically agricultural, and the soil is carefully worked so that the millions of natives may secure a livelihood.

R-19 The growth of Egyptian and Babylonian civilizations appears to have been closely associated with the successful development of __________ in areas of alluvial soil materials.

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S-20 Unlike fusion, fission takes place without requiring an extremely high temperature.

R-20 Unlike fusion, ________ takes place without requiring an extremely high temperature.

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S-21 Unlike fusion, fission takes place without requiring an extremely high temperature. Only two things are actually needed: (1) a heavy atom whose nucleus will undergo fission and (2) a slow neutron that can make fission occur.

R-21 Only two things are actually needed: (1) a __________ atom whose nucleus will undergo fission and (2) a slow neutron that can make fission occur.

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S-22 Unlike fusion, fission takes place without requiring an extremely high temperature. Only two things are actually needed: (1) a heavy atom whose nucleus will undergo fission and (2) a slow neutron that can make fission occur. Here is a very simple explanation of what happens. The neutron first hits the nucleus of the atom. Then the nucleus splits, releasing energy.

R-22 Unlike fusion, fission takes place without requiring an extremely high

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S-23 Unlike fusion, fission takes place without requiring an extremely high temperature. Only two things are needed: (1) a heavy atom whose nucleus will undergo fission and (2) a slow neutron that can make fission occur. Here is a very simple explanation of what happens. The neutron first hits the nucleus of the atom. Then the nucleus splits, releasing energy. From one to three neutrons are given off, too. If one of these slows down enough to hit the nucleus of another heavy atom, its nucleus also splits. More energy is released and more neutrons given off.

R-23 Here is a very simple explanation of what happens. The neutron first hits the __________ of the heavy atom.

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S-24 Unlike fusion, fission takes place without requiring an extremely high temperature. Only two things are actually needed: (1) a heavy atom whose nucleus will undergo fission and (2) a slow neutron that can make fission occur. Here is a very simple explanation of what happens. The neutron first hits the nucleus of the atom. Then the nucleus splits, releasing energy. From one to three neutrons are given off, too. If one of these slows down enough to hit the nucleus of another heavy atom, its nucleus also splits. More energy is released and more neutrons given off. So what is called a chain reaction is started. The chain reaction keeps itself going until all the nuclei have split or not enough neutrons are left to make them split.

R-24 The chain reaction keeps itself going until all the nuclei have split or not enough ________ are left to make them split.

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S-25 The Puritans could not stem the rising tide of liberal thought in the colony, but they tried. First Mrs. Annes Hutchinson, a lady of fine birth, was banished for expressing her religious convictions, and the subsequent slaughter of her entire family by the Indians was considered a judgment of God. Next they turned on the Quakers, even putting some of them to death. Massachusetts was unique in the length to which it went in these persecutions.

R-25 The slaughter of Mrs. Hutchinson's entire family by the __________ was considered a judgment of God.

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S-26 Of a large number of pupils in school (including seniors expecting to go to college) 60 percent indicated that they would drop out if they thought that their school work would not improve their vocational chances. Three-fourths of those who were planning to leave reported that they would return for at least another year if they were reasonably sure that doing so would enable them to get better jobs.

R-26 Three-fourths of those who were planning to leave reported that they would return for at least another year if they were reasonably sure that doing so would enable them to get better __________.

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S-27 Machiavelli's political thinking, like that of most of the ancients, is in one respect somewhat shallow. He is occupied with great law givers, such as Lycurgus and Solon, who are supposed to create a community all in one piece, with little regard to that which had gone before. The conception of a community as an organic growth, which the statesman can only affect to a limited extent, is in the main modern, and has been greatly strengthened by the theory of evolution.

R-27 The conception of a community as an organic growth is in the main modern, and has been greatly strengthened by the theory of __________________.

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S-28 From the English translation of the Bible
"Who can find a virtuous woman? For her price is far above rubies. The heart of her husband doth safely trust in her, so that he shall have no need of spoil. She will do him good and not evil all the days of her life. She seeketh wool, and flax, and worketh willingly with her hands. She is like the merchants' ships; she bringeth her food from afar. She riseth also while it is yet night, and giveth meat to her household, and a portion to her maidens."

R-28 "Who can find a ____________ woman?...."

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S-29 The newly born infant squirms about aimlessly, slashing wildly with his arms and legs, responding vigorously but indiscriminately to various forms of stimulation. His behavior is completely undifferentiated, diffuse and random. He "wants" food, for example, and he will respond in the same manner to a nipple, a finger, or a rattle. Patterns of behavior are non-specific, except for general tendencies to get more of some stimuli and to get less of others.

R-29 The newly born infant responds vigorously but indiscriminately to various forms of ____________________.

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S-30 Iron is the most important metal on earth. We have only to look around us to discover how important iron and steel are in our civilization. Millions of tons of iron and steel are produced and used in this country annually.

R-30 Millions of tons of iron and ________ are produced and used in this country annually.

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S-31 From our everyday experience, we have become familiar with the fact that matter occurs in three different forms -- solid, liquid and gas. Under ordinary conditions stone, iron, copper, and chalk, for example, are solids; water, oil, and mercury are liquids; air, hydrogen, and carbon dioxide are gases. Each one of these forms is called a phase. At times it is difficult to distinguish clearly between the solid and the liquid phases, as in a material such as tar which flows under the action of a force at ordinary temperatures. Metals at high temperatures flow or "creep" under the action of a force. Even where the different phases are clearly recognizable, materials undergo a phase change under different conditions of temperature and pressure.

R-31 Even where the different phases are clearly recognizable, materials undergo a ______________ change under different conditions of temperature and pressure.

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S-32 A map projection is said to be conformal, or orthomorphic, when any small piece of the earth's surface has the same shape on the map as it does on the globe. Thus, the appearance of small islands or countries is faithfully preserved by a conformal map. One characteristic of a conformal projection is that parallels and meridians cross each other at right angles everywhere on the map, just as they do on a globe. However, not all projections whose parallels and meridians cross at right angles are conformal.

R-32 A map projection is said to be _____ when any small piece of the earth's surface has the same shape on the map as it does on the globe.

S-33 Historians of all political shades will readily concede that the storming of the Bastille of Paris, on July 14, 1789, was not in itself a glorious action. It was instigated by shady men for shady motives, carried out by a disreputable mob, and abetted by disloyal soldiers. The defenders - a handful of invalid veterans and their officers - capitulated almost without resistance. Despite the terms of capitulation, the mob killed the commandant and two of his officers; a scullion boy, skilled in the art of meat cutting, severed the commandant's head, which was then paraded about on the point of a pike. The total number of prisoners liberated from the fortress was seven. Of these, four had been detained for forgery and disappeared immediately. A fifth, a young debauchee held on his families request, allowed himself to be feted by the revolutionary societies and made speeches announcing the dawn of freedom. The other two, who were madmen, were carried through the streets on the shoulders of their liberators and then hastily locked up in the insane asylum of Charenton.

R-33 The total number of __________liberated from the fortress was seven.

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S-34 Wave motion is an important method of transferring energy from one place to another without involving the actual transfer of matter. When a pebble is dropped into a still pool, some of the kinetic energy of the pebble is used to generate the ripples which spread out in all directions over the surface of the pool. When the ripples pass by a floating object, such as a bit of cork, the cork bobs up and down, having acquired its kinetic energy of vibration from the ripple system. The ripples thus serve to deliver some of the energy of the pebble to the distant cork. Although the ripple system is seen to move, there is no net flow of the water, for the cork simply bobs up and down and does not move in the direction of the ripples. Since the cork merely provides visible evidence of the behavior of the water, we may infer that the motion of the water is one of vertical oscillation, while the motion of the wave is horizontal; that is, the oscillations of the water are transverse to the direction of propagation of the wave. A wave motion in which the vibrations of the medium are perpendicular to the direction of propagation is called a transverse wave. The waves set up in a taut string when one end of the string is vibrated in simple harmonic motion are transverse waves.

R-34 The waves set up in a taut string when one end of the string is vibrated in simple harmonic motion are ___________waves.

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S-35 Some parents spoil their children by wanting to spare them the struggles they, themselves, went through together to find economic security, failing to realize that some toughening and struggling is wholesome for young people in facing life together. They need not shield youth from all hardship.

R-35 Some parents _________their children by shielding them from all hardship.

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S-36 Perhaps the most striking difference between the political history of France since 1789 and that of Great Britain and the United States in the same period is the lack of constitutional continuity. Since the Glorious Revolution of 1688 Great Britain has had no violent change in its government. Since 1789 the United States has had only one constitution and has had no successful rebellion. But the story of modern France is largely one of recurrent revolutions and threats of revolution. In contrast to Anglo-American political continuity, France since 1789 has been three times a constitutional monarchy, twice an empire, once a semi-dictatorship, and four times a republic.

R-36 Perhaps the most striking difference between the political history of France since 1789 and that of Great Britain and the United States in the same period is the lack of constitution__________.

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S-37 The mathematical symbols first encountered by everyone are those of the positive integers: 1, 2, 3, 4, ... These are often called the natural numbers. Their properties are familiar to all, and we shall list them systematically.

R-37 The positive integers are also called the __________numbers.

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S-38 The electrons in the outermost groups of an atom are the ones that are involved in reactions. Since they determine the combining capacity of the atom, they are sometimes spoken of as the valence electrons of the atom, and the group to which they belong is called the valence group, or valence shell.

R-38 The electrons in the __________groups of an atom are sometimes spoken of as the valence group.

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S-39 The merits of Hobbes appear most clearly when he is contrasted with earlier political theorists. He is completely free from superstition; he does not argue from what happened to Adam and Eve at the time of the Fall. He is clear and intelligible, and does not involve the use of any dubious concepts. Apart from Machiavelli, who is much more limited, he is the first really modern writer on political theory.

R-39 Apart from Machiavelli, who is much more limited, Hobbes is the first really __________writer on political theory.

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S-40 The type of organization which exaggerates the importance of the maternal uncle in family affairs in called the avunculate. Where it is found, children may be particularly fortunate in that they have two fathers: their actual father, who plays with them, teaches them his techniques and lore, takes them hunting or visiting and is, in general, a fine adult companion; and the uncle who, because of his social and economic obligations to his sister's children, sees to it that they learn the lessons of the tribe and grow up to be responsible men and women.

R-40 The type of organization which exaggerates the importance of the maternal __________in family affairs is called the avunculate.

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SAMPLE OF SUB-SET OF "THINKING QUESTIONS"

(INTRODUCTORY NOTE: The five units which follow are taken from the only set of questions from the first stage of Step Three-B that has been prepared. Five additional units complete the set. The entire set has been tried out on two college sophomores, who ran fairly smoothly through the items with gratuitous, but happily-received, comments to the general effect that "they certainly made me think.")

P-1 The Germans were a fair-haired, blue-eyed race of men who had towering stature and terrible strength. In their native forests of the North, each German nation occupied a very limited area, probably not over forty miles across; in numbers such a people had not usually more than twenty-five or thirty thousand souls. They lived in villages, each of about a hundred families, and there was a head man over each village. Their homes were but slight huts, easily moved. They had little interest in farming and fringe of fields around the village, much preferring their herds, and they shifted their homes often. They possessed no writing and very little in the way of industries, manufactures, or commerce. A group of noble families furnished the leaders (dukes), or sometimes kings, governing the whole people.

^{S}A-1 What is the difference between the government of the primitive German village and the government of the German people as a whole?

^{R}A-1 Each village had its own leader or head man; however the German tribes as a whole were ruled by men selected from among certain noble families.

^{S}T-1 As you probably know, the German people were essentially barbarian before their conquest of Rome in the fifth century, at which time they acquired the more refined culture of civilized Rome. Why do you think the Germans had not created a more highly developed culture of their own before this?

^{R}T-1 A number of factors might have contributed to the fact that the German tribes produced no highly developed culture of their own. The fact that they had no system of writing limited the extent to which they could transmit knowledge, and their lack of interest in farming made unlikely the formation of towns and stable communities which could serve as cultural centers. Their nomadic existence and crude industry and commerce probably provided little leisure time that could be used to develop the luxuries associated with civilization.

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P-2 A scientific method is a way a scientist works. He does not follow a particular set of rules, nor does he accumulate his data by any single method. The method in use among the various sciences, and even within a single science such as psychology, must of necessity, differ greatly. Scientific methods are guides whereby the scientist may discover the most valid and reliable data on the problem that confronts him. The astronomer, for example, can only make observations of the movements of the stars; he cannot change their courses nor can he experiment with them. He is able, nevertheless, to make some of the most accurate predictions known to science In many instances the psychologist also must resort to observation; he may not damage an area of the normal human brain to discover the effect on a person's memory or thinking, but he can observe and record the effect of brain damage--tumors, war injuries, accidents, and manipulate and control every significant factor.

^{S}A-2 Generally the specific methods used by astronomers and psychologists in collecting their data are different. However, in what one way are they similar?

^{R}A-2 The scientific method of psychologists and astronomers is similar in that they both use observation.

^{S}T-2 Give an example of something less abnormal than the effects of brain damage which a psychologist might want to observe in studying behavior scientifically.

^{R}T-2 Really, almost anything that people do is of interest to psychologists, so that in a way they might want to observe any sample of behavior for purposes of scientific study. Good examples of specific behaviors they might want to observe would be: The kinds of things a person talks about, the numbers of friends and acquaintances he has, the various kinds of activities he engages in, and so forth.

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P-3 In the illumination of the BOOK OF KELLS, Irish art came to the full realization of its own genius. The volume is a gospel book of thick vellum. There are now 339 leaves, but there must originally have been more. The book suffered mutilation on at least two occasions. In 1007, it was stolen for the value of the cover, and found buried under a sod. About 1800 or a little later, a new binding was put on, and the binder barbarously cropped the pages to their present size of about 13 by 9½ inches, spoiling the placement of the ornament on the pages and actually cutting into some of the compositions. The history of the manuscript is well known. When the monastery at Kells was surrendered to the Crown in 1539, the book was there and Richard Plunkett was Abbot. We hear of it next in the hands of one Gerlad Plunkett of Dublin, who wrote some notes on it; and from this later Plunkett, the book went to a man named Issher. Issher's entire library came to Trinity College in 1621.

^{S}A-3 What was the reason for the first misfortune to befall the BOOK OF KELLS?

^{R}A-3 It was stolen for the value of the cover.

^{S}T-3 How might you account for the fact that a work of art like the BOOK OF KELLS is at times partially destroyed and occasionally lost?

^{R}T-3 Many factors such as vandalism, natural catastrophies, social conflicts, war and fire certainly play a part in causing works of art to be temporarily lost; however, an important cause is often simply that people fail to recognize its value and significance enough to take extreme care of it.

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P-4 Sculpture is probably as old as surface decoration. In fact it is difficult to determine where a deeply scratched line ceases to be surface ornamentation and takes on the aspect of relief. In Europe, sculpture goes back to the Aurignacian, like painting; here, sculpture in the full round, as well as in relief, has been found by archaeologists. Despite its age, however, it is not, like painting, universal; many people make no use of sculpture at all. The materials used in sculpture include stone, bone, wood, ivory, clay, and metal. Clay may be used for modeling or for molding; the latter is usually late and implies mass production. Two principal areas in which sculpture in the round is the characteristic art form are Negro Africa and Melanesia. In Negro Africa, wood, ivory, and metal are the principal mediums. The technique is a realistic representation of the human figure in which color is unimportant, since all are uniformly brown, except in the case of ivory; but surface texture is supremely important; a rich, glossy, smooth surface is one of the chief attributes of this sculpture. African figures are stylized, as a rule, in pose and expression, but individual variations are expressed by subtle differences in a few facial features; this is especially true of the elaborate masks so characteristic of West African art. Melanesian and Papuan carving is as a rule even more conventionalized.

^{S}A-4 What are the chief characteristics of African sculpture?

^{R}A-4 The media are wood, ivory, and metal and the form is a realistic representation of the human form.

^{S}T-4 Why do you think primitive tribes went to the trouble to make sculptures?

^{R}T-4 It is, of course, difficult to appraise accurately the motivation of primitive people in producing their art work; however, the following factors may have been involved. The sculpture may serve simple decorative purposes in making the living environment of the people more interesting, or the art work may have played some role in the religions or social ceremonies of the tribe. Then too, the sculpture may have been produced simply out of the drive of an individual to create something he found pleasing to look at.

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P-5 Parents of successful leaders show outstandingly different attitudes from the parents of other groups of children. The contrast is most marked when they are compared with parents of asocial children, especially parents of outcasts and over-looked children. In general, parents of successful children are less inclined (1) to protect children from the normal risks of life, (2) to shield them from the normal responsibilities of life and to prevent them from developing an adequate degree of independence which is so necessary for good mental health and normal functioning in the social groups. (3) They tend to be less restrictive in the degree of control they exercise over the child; (4) much more leeway is allowed the children in making decisions, using judgment and experimenting with new situations; (5) the individual personality is given far more respect--his rights and his opinions are given consideration in the family group; (6) the parents appear to possess superior ability in evaluating forms of child behavior and characteristics of child personality which are desirable for the optimal development of the child himself.

^{S}A-5 What is the relationship between successful children and the parental ability to evaluate forms of child behavior?

^{R}A-5 Parents who possess superior ability in this evaluation have more successful children.

^{S}T-5 As stated in the above paragraph"...parents of successful children appear to possess superior ability to evaluate forms of child behavior and characteristics of child personality which are desirable for the optimal development of the child himself."

As an example of child behavior: a four year old girl is found in the back yard wearing her mother's best high-heeled shoes, best Sunday hat, and a $150.00 suit which her mother had bought the week before. She is walking in the gravel; the suit is dragging the ground, and her muddy hands are holding the hat on her head. Now, in keeping with the above quotation from the paragraph, write how you feel the parents of a "successful child" would react.

^{R}T-5 The parents' first inclination would be to spank the child. Upon reconsidering, the parents would evaluate the behavior of spanking in light of its possible consequence to the child. In this particular instance, the spanking would be valueless, as the child's behavior must have been motivated by imitation or emulation of the mother. Based upon this concept, the parents would strive to guide this behavior into acceptable channels by explaining to the child that she should have asked permission before wearing her mother's clothes. They may explain to her the damage being done. Ownership may be discussed, and the child may be given clothing which she may use for play.